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August
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No Trans-Atlantic Air Service for Twenty Years,

Commander Byrd Says in an Analysis of Lindbergh's Flight Page 9

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WHAT IS NEW THIS MONTH

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More Than 250 Striking Articles in This Single Issue Cover from Every Angle the Latest Developments in the World of Invention and Discovery

New Devices for the Home

New Processes and Inventions

Photography

Radio

Ships

Unusual Facts and Ideas

Hints for the Mechanic

Ideas for the Handy Man

Even Your Electric Toaster Helps Pay Public Utility *Dividends*

By WALLACE AMES, *Financial Editor*

"SPEAKING of bargains," remarked Mr. Crane to his thrifty wife, as he looked up from the evening paper, "this ought to interest you. Here is an advertisement by the Electric Light and Power Company showing nine electrical appliances for home use which all together cost only $1 a week to run.

"This advertisement says that the current consumed by a hair dryer used one hour each day costs only 4c a week. We can run an electric bath room heater twenty minutes every morning for 9c a week. How about an electric vibrator? You can massage with it one hour a day, if it takes that much time getting the kinks out of your system, for 2c a week. Gee! I never realized that there were so many uses for electric current, and that it was so inexpensive. Did you?"

"I began to realize it this afternoon," replied Mrs. Crane. While I was down town I had a little time and so stopped in at the show room of the Electric Light Company. And I could hardly tear myself away. There were so many clever, labor-saving electrical contraptions there.

"Why, with a few of those little contrivances I could get our house work done in less than half the time it takes me now. And they do things so well.

"Let's look over our budget, plan it over a bit, so we can buy more electrical things."

Mr. and Mrs. Crane's observations suggest a very big, important reason why public utility securities are today rated as sound investments. Public utility companies are making great strides in the matter of increasing the market for their services.

SOMEONE, whose name we do not recall, was asked how to become wealthy. His terse reply was: "Make something that everybody wants." That comes pretty close to describing what the electric light and power companies have been doing these last several years. Only they have been producing something that everyone not only wants, but *needs*.

When the industry was in its infancy, not so many years ago, electric current was used for lighting and to a certain extent for factory power. The progress that has been made within recent years in increasing the use of electric current makes the imagination stagger.

Let's begin with wired homes. Ten years ago only 5,160,000 homes, or 12 percent of the country's total were wired for electricity. Today the number has been increased to 16,000,000 or approximately 60 per cent. Thus, within ten years the utilities have increased their potential home market nearly 300 percent. Once a home is wired, every additional electrical appliance used adds to the utility company's revenue without adding commensurately to its overhead.

Whereas, in the beginning, electricity was used in the home for lighting only, nowadays it seems as though almost everything is done by electricity. There are at least 39 domestic appliances consuming electricity, such as irons, vacuum cleaners, refrigerators, oil heaters, sewing machines, washers, radio sets, etc.

DURING 1926 the retail value of various electrical appliances sold reached the total of $775,828,000. Radio sets and accessories added another half billion. Not only did the utility companies make a normal profit for their investors on their proportion of this accessory business, but the installation of all these appliances means a permanent increase in the use of electric current.

Your vacuum cleaner means a market for from $1 to $4 of electric current per year. And there were a million new vacuum cleaners sold last year. Your coffee percolator means from $1.50 to $6 of current. And some four hundred thousand percolators were sold last year. If we were to go on through the entire list of electrical appliances we would find that they alone increase the income of the utilities by millions upon millions of dollars per year.

Lest the reader begin to calculate that he is spending too much money on electricity it might be interesting here to insert that the total year's electric bill for the average family is only $27.89. The valuable and convenient services which we get from electricity are among our most trivial of expenses.

While great strides have been made in increasing the sale of electric current in the home, similar progress has been made in commercial and industrial fields. Electric power has replaced steam power in factories. Industrial plants, office and apartment buildings, hospitals and various types of institutions which once generated their own power have in numberless cases discontinued their own generators to become big customers of the central stations.

MODERN advertising has done its share to increase the use of electric current. Look at all the electric signs, and the brightly lighted store windows. Civic pride has helped with its "White Way" street lighting.

An indication of the increased market for power in industry is given by the figures on motor horsepower operated by electricity purchased from central stations. The figure in 1914 was 3,884,724. By 1923 it had increased to 13,365,663. More recent figures are not available.

Including domestic, commercial and industrial uses, there are now fully three thousand separate ways in which electric current is used. In the one year, 1926, nearly one and a half million new customers were added to the books of electric light and power companies, bringing their total up to nearly twenty million customers. Each department, domestic lighting, commercial lighting, and power customers, has shown an increase around 300 percent during the last 10 years.

IT DOES not automatically follow that any and all public utility securities are good investments, just because the industry as a whole is in good condition. Reputable investment bankers scrutinize every piece of public utility financing with great care. Their engineers and lawyers go into every detail. Reports in the files of bankers are voluminous and complete. Each individual offering of stock or bonds is made to the public on its individual merits, not alone on the status of the industry as a whole.

[Statistics in this article based on researches made by Electrical World and Electrical Merchandising.]

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POPULAR SCIENCE MONTHLY

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The House Behind the Bonds reminds the investor of the importance, not only of studying the investment, but of checking up the banker who offers it. Address: Fidelity Bond & Mortgage Co., 1188 New York Life Building, Chicago, Ill.

Behind the Scenes where Bonds Are Made tells how you can retire in fifteen years and have an income equal to your present living budget. This booklet can be secured by writing to Cochran and McCluer Company, 46 North Dearborn Street, Chicago, Ill.

WHILE investments obviously cannot be guaranteed by the Publisher, every effort will be made to insure that only advertisements of absolutely reliable companies are accepted.

Address your inquiries to Wallace Ames, Financial Editor, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York.

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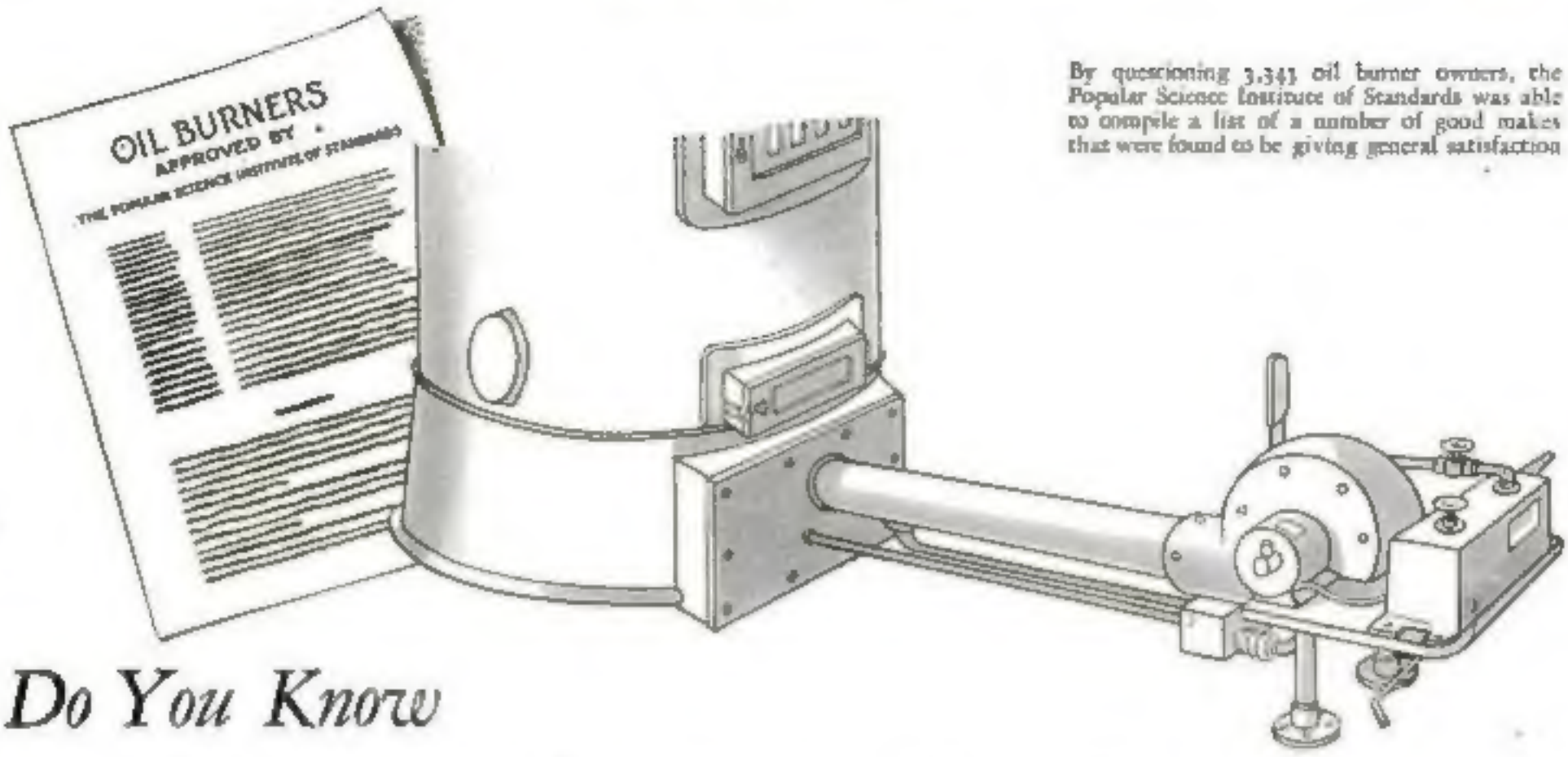

By questioning 3,343 oil burner owners, the Popular Science Institute of Standards was able to compile a list of a number of good makes that were found to be giving general satisfaction

Do You Know

The *TRUTH* ABOUT *OIL* BURNERS?

OPEN up a booklet on oil burning in any train, waiting room or public place, and it is almost a certainty that the stranger next to you will start a conversation. This unfailing interest is seldom accompanied by any particular knowledge on the subject, either. For if more people *really knew* about oil burners, they would not just be interested but would *own* one of these truly wonderful devices.

When it comes to knowing about oil burners and the degree of satisfaction they give, the Popular Science Institute of Standards probably has more complete and impartial knowledge on the subject than any other organization. The Institute has spent a year's time and several thousand dollars in gathering the data that it has on oil burners.

The one outstanding fact determined by the Institute's investigation is that *practically every owner of a good oil burner is satisfied* and considers that his burner has lived up to the promises made for it. One thing is certain—if the public as a whole were as fully convinced of the efficiency, convenience and comfort of oil burners as is the Institute, there would be few homes without them.

This opinion is based on the data in the Institute's possession after questioning 3,343 oil burner owners located in 252 cities in 30 different states. The findings were entirely impartial, the whole investigation being conducted by the Director of the Popular Science Institute, Dean Collins P. Bliss of the College of Engineering, New York University.

This investigation was undertaken for three reasons. First, to secure general information on this subject in which readers had shown considerable interest. And, in the second place, to be able to authoritatively advise readers just what makes of burners would give them good results. The third reason for the investigation was to protect both POPULAR SCIENCE MONTHLY and its readers in regard to oil burner advertisements in the magazine. All oil burners advertised in POPULAR SCIENCE MONTHLY are covered by the publisher's guarantee. POPULAR SCIENCE MONTHLY cannot, and will not, carry the advertising of any but reliable burners.

Over 1400 readers have already written the Institute and asked for specific recommendations of oil burners for their homes. Many of them have written telling us that they have installed burners recommended by the Institute and how pleased they are with the results. One of these new owners recently wrote, "I only wish I had asked you before; our oil burner has been such a comfort." This seems to be the general attitude.

The difference between heating with oil and with coal is, they have found, the difference between having an evenly heated warm home instead of a too hot or too cold one; between absolutely forgetting heating problems, and shoveling, sifting and constantly attending a furnace. As to the cost of using the two types of fuel, most owners report slight difference—a few spend less, some spend slightly more for oil than for coal, but the majority find the cost about equal.

Then there is the question of service. Many people who have had no experience with oil burning are under the impression that frequent service calls are customary and necessary. This is not true. Good burners, such as those on the approved list of the Popular Science Institute of Standards, require little servicing and such service as is required receives prompt attention, with no inconvenience on the part of the owner. Contrast this with the daily calls of the furnace tender and ashman when coal is the heat supply!

Readers writing for recommendations of burners should tell (a) number of rooms in the house, (b) type of heating system, (c) average annual coal consumption, (d) whether gas and electricity are available. Address the Popular Science Institute, 250 Fourth Ave., New York, N. Y.

Popular Science Monthly
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The above seal on an advertisement indicates that the products referred to have been approved after test by the Popular Science Institute of Standards.

POPULAR SCIENCE MONTHLY guarantees every article of merchandise advertised in its columns. Readers who buy products advertised in POPULAR SCIENCE MONTHLY may expect them to give absolute satisfaction under normal and proper use. Our readers in buying these products are guaranteed this satisfaction by POPULAR SCIENCE MONTHLY.

THE PUBLISHERS

Get the benefits of *high compression*

AUTOMOTIVE engineers have long known that the efficiency of gasoline engines increases as their compression is raised.

The compression of the present day automobile is as high as the limitations of ordinary gasoline permit. Gasoline is not a perfect fuel. It explodes too soon (*i. e.*, "knocks" and loses power) when compressed beyond certain limits.

That is why automotive research devoted many years to the development of "ETHYL" fluid, which, when mixed in very small quantities with motor gasoline, eliminates its knocking tendencies and makes it a high compression fuel. The fuel so mixed is Ethyl Gasoline.

Ethyl Gasoline has brought the benefits of high compression—greater power and flexibility, faster pick-up, reduced gear-shifting—to hundreds of thousands of motorists. This is because carbon deposits raise the compression of your engine beyond the point at which it was designed to perform efficiently with ordinary gasoline.

Try Ethyl Gasoline to-day. Enjoy a driving satisfaction and engine performance that you have never before experienced with your car. The "ETHYL" trademark shown above identifies the Ethyl Gasoline pump.

ETHYL GASOLINE CORPORATION, 25 BROADWAY, NEW YORK CITY

What high compression means to you

THE principle of high compression is readily understood. The tighter you pack the powder charge in a muzzle loading gun, the greater the force given the bullet. Similarly, the tighter gasoline vapor and air are compressed in the combustion chamber (the space between the head of the cylinder and the top of the piston) before ignition, the greater the power derived from the explosion.

Increasing compression therefore simply means decreasing the size of the combustion space, which may be accomplished mechanically or through the formation of carbon.

Higher compression means a more powerful and flexible car, less gear-shifting, faster pick-up. In short, a performance impossible with lower compression and the use of ordinary gasoline.

ETHYL GASOLINE

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Popular Science MONTHLY

AUGUST, 1927 SUMNER N. BLOSSOM *Editor* VOL. III, NO. 2

Commander Byrd Tells~

Why We May Wait 20 *Years for* Ocean *AIR* Lines

An Analysis of the Trans-Atlantic Flights of Lindbergh and Chamberlin, by the Man Who First Flew to the Pole

THE world, while rejoicing over Charles Lindbergh's superb feat of flying alone from New York to Paris, and, two weeks later over the equally amazing achievement of Clarence D. Chamberlin and Charles A. Levine in flying to within 110 miles of Berlin, has largely obscured the fact that they made thereby priceless contributions to the science of aeronautics.

Thousands of columns that for weeks flooded the world's newspapers justly extolled the fine courage of the trans-Atlantic flyers. Much was made of the risks they took. I, for one, regret that so little praise was bestowed upon the pilots' technical skill which went into preparations for and execution of their stupendous flights.

In my opinion, which is supported by a wide circle of aviators, Lindbergh and Chamberlin both demonstrated three important things: they took what were virtually commercial type planes and flew them 3600 and 4100 miles, respectively, without mishap, proving that their craft were no freaks; they steered the whole way by compass, demonstrating that the new earth inductor compass was a highly reliable instrument, and they kept their air-cooled motors turning unceasingly the whole way, a test which alone was nearly worth their entire efforts.

Many have disparaged the flights as a contribution to commercial transoceanic air lines. In Lindbergh's case they called attention to the fact that he flew alone, and declared that no passenger would ever risk portage in a single motored machine. Then, when Levine surprised even his wife and friends, at the last moment, by taking passage over the Atlantic with Chamberlin, it was pointed out that, since dropping out of the sea likely would have meant death, there was no more a pretense of exploit than the stunt of a man walking a tightrope across Niagara Falls.

The author, Commander Richard E. Byrd wearing the Congressional Medal of Honor awarded to him for his flight to the Pole

AMONG the millions who anxiously followed the trans-Atlantic flyers in their amazing hops to Europe was one man who, better than any other, knew the perils surrounding them, and the skill required to carry them through. That was Commander Byrd, first to fly over the North Pole, and one of the world's foremost aerial navigators. For him, the flights over the ocean were no dare-devil race. They were thoughtful, courageous efforts to advance aviation.

POPULAR SCIENCE MONTHLY considers itself fortunate to present to its readers Commander Byrd's own analysis of these great achievements, and his graceful tribute to the pilots who accomplished them. He gives us an authoritative picture of the enormous work to be done before regularly scheduled air liners can follow the lonely trail blazed by the *Spirit of St. Louis* and the *Columbia*.

THESE are not sound criticisms. Blériot on his first crossing of the English Channel, was doing what in the mind of the public was a dare-devil feat. Yet his example inspired engineers and capitalists to establish a London-Paris air line that now operates daily. Even in the crazy days of our transcontinental railroads records show that people thought an engine breakdown would be fatal, either from the bitter blizzards that swept the prairies, or from lonely hawking Indians who would swoop down upon the unprotected train. Yet each crossing of our country brought men nearer to the dazzling and service now at the disposal of a traveler.

Today ocean flying is still a gamble. Neither Lindbergh nor Chamberlin, by their gallant voyages, have made it otherwise. It will be some twenty years, in my opinion, before regular commercial trans-Atlantic air service is established. What these two pilots have done, though, is to reveal the nature of the hazards by first-hand experience, and, like Blériot, to inspire men with new confidence that they are not too great to be conquered eventually. They have demonstrated for one thing, that ocean flight will remain a gamble until we have full and accurate knowledge of weather over the sea. Heretofore ocean weather data have been collected haphazardly.

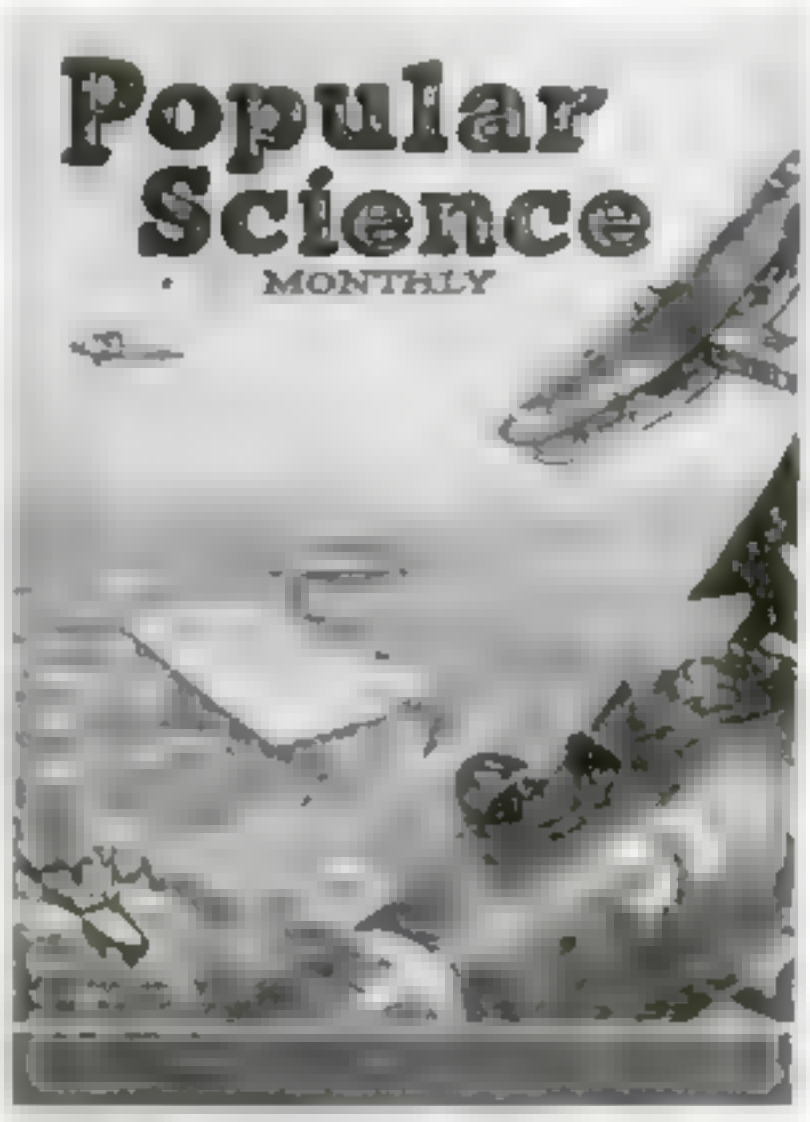
All of us who look forward to ocean flying in the future have examined

every detail of the weather records Lindbergh and Chamberlin brought down with them, for theirs is the first complete first-hand list of conditions obtained over the Paris–New York route within a limited period of time.

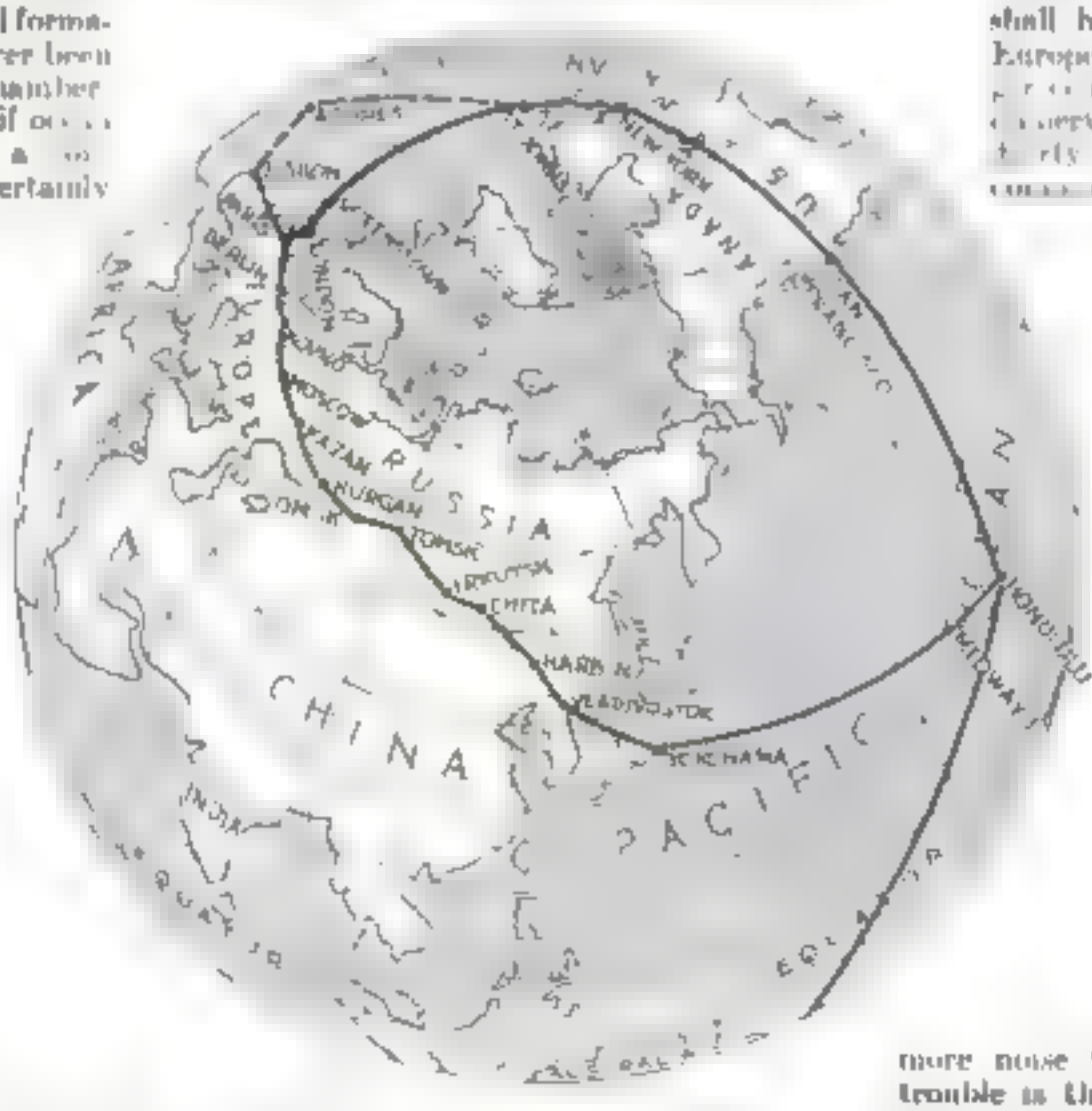
OUR governmental Weather Bureau has made a science out of weather prediction for this country. Storms can be foretold; precipitation and temperatures can be approximated in advance; and the severity of the seasons has become almost a matter of mathematical tables. But we know relatively little about the weather over the ocean. Of course, it roughly follows that of the contiguous land to the westward. This is so because the prevailing wind motion in the North Atlantic is from west to east. Vessels making passage from Europe to America regularly submit their meteorological data through various channels to our Navy Hydrographic Office in Washington, D. C. So-called "Pilot Charts" give the digests of these reports at regular intervals. In preparing the *America* for our planned flight across the Atlantic, we had the cooperation of the Radio Corporation of America and the Weather Bureau. Both relayed to us the daily reports of vessels at sea regarding the state of weather they were encountering. But this was far from enough on which to base commercial flying over the ocean.

For one thing, such reports are based on only spasmodic observations by passing ships. Then they are, of course, taken at sea level. Depth of fog, height of wind disturbances, thickness of cloud formations and the like have never been gathered. Lindbergh and Chamberlin have made it plain that if ocean flying is to be practicable, a continuing weather service will certainly have to be established, with large central receiving stations at New York, London and Paris.

Of other danger factors that must be eliminated, most important is chance of engine failure. At once we realize that the single-engined planes which Lindbergh and Chamberlin flew would have to be replaced by a multi-engined machine capable of being kept aloft by only part of its several engined units. For instance, a plane with ten engines might readily be designed to fly with only six of them. In emergency certain weights such as landing gear might be dropped, and thus let even fewer engines keep the plane aloft.



The proposed "seadrome" or giant floating hangar designed as a way station for ocean flight by Edward R. Armstrong, noted engineer, as pictured on the cover of POPULAR SCIENCE MONTHLY last October. Lindbergh and Byrd both express belief in the necessity of some such plan



The Lindbergh and Chamberlin flights open the fascinating possibility of girdling the earth by airplane in a series of hops, indicated on this map. No single hump would be longer than the 3600-mile stretch from New York to Paris

CERTAINLY there will have to be landing stations along the way. Lindbergh himself has expressed his favor of great floating hangars anchored in the ocean, that would in effect be man-made islands, provided with food, sleeping quarters, fuel supplies and wireless station.

I am convinced that a proposed "seadrome," or floating hangar, such as the one designed by Edward R. Armstrong, chief experimental engineer for E. I. du Pont de Nemours and Company, will soon prove practical. The idea is sound. As soon as the proper engineering skill gets behind the move and funds are provided for such ventures, they can be built. The greatest problem will be to anchor the floats. Seadromes should be common sights over the ocean within a few years. These would be supplemented by landing fields on the land bordering the route; Newfoundland and Ireland for the northern route, and the Azores and Portugal for the southern one.

In the future, too, there will have to be fast patrol craft along the air lanes to act both as lightships and rescue units.

WHEN Commander Read flew the Atlantic some years ago he hopped to Newfoundland and thence to the Azores. Along his route were stationed many naval vessels. Yet when his companion flyer, Commander Towers, fell into the sea it took the rescue vessels some time just to find the plane. In this connection the passenger or express plane will have to have a seaworthy hull so that she can float for an indefinite time and even make some way through the water. She will have to be equipped with radio that can be used afloat as well as aloft. That is not the case with our present plane radio equipment.

Thus, for a long time, only the seaplane type of aircraft will do the dependable cross-sea flying.

There is bound to be great advance of airplane design before we shall be able to buy a ticket to Europe by air. No average passenger could stand the present strain on nerves and body that more than thirty hours aloft entails. It is a common thing for passengers on the Paris-London route to arrive with green faces and heaving stomachs due to air sickness resulting from their plane's leaping about over the Channel. As with steamers, the relief for this misery will be in larger and larger planes.

OTHER nerve strains will be reduced even before passenger service becomes a factor in plane design. One is the constant roar of an airplane's motor. Even to the accustomed pilot this is always disagreeable. Mufflers already have been designed. Only a few weeks ago a plane flown over the Hudson River made little more noise than an automobile. The trouble is that the muffler reduces the power of the engine. But when there are many engines in one plane this need not make so much difference.

Much has been done in the way of

personal service aboard planes used for short passenger routes in Europe. Meals can be served and naps taken. But in the day and a half crossing of the Atlantic by air the passenger will have to be warmed and fed and entertained if his patronage of the line is to be kept.

NO DOUBT heating will be done by utilization of the exhaust of the engine. Regular dining car service can be installed without the addition of much weight. Radio will provide entertainment. However, all these things are easier said than done. And some years will have to pass before the small refinements so indispensable to the critical traveler can be perfected.

This year the Germans, in particular, have gone well ahead with design of passenger planes. They are building a machine that utilizes the wing for space for passenger cabins. This means a wing six to ten feet thick. At first thought, such a condition would seem detrimental to the plane because of wing resistance. But it is the vacuum above a wing rather than the push of air under it that stands for lifting power. Therefore, a deep wing front is really beneficial. The trans-Atlantic plane of 1930 may have wings thick enough for two tiers of cabin and stowage spaces.

Naturally the multi-engine plane must have its engines accessible from the central station. This may seem a superfluous remark. Yet I believe this was never done until 1926; and that only one tri-engined plane today has a "cat-walk" from its cockpit to the outboard engines. This is a good example of how much has to be accomplished before the feats of Lindbergh and Chamberlin can be up with practical commercial flying over the same route.

As planes grow the fire risk will grow with them. In the *America* we have a quick dumping device for emptying our fuel tanks if we see that a crash is inevitable. The tragic accident to Captain Frank's plane last year was a sample of the peril from a quick blaze.

Yet quick dumping of fuel is not the final answer. Surely there should be developed a fuel that is not so highly inflammable as gasoline. Possibly some form of alcohol can be got from cellulose that will make a cheaper and safer fuel. I suppose that even a very high powered storage battery may be devised some day. But we are far from it now.

I HAVE been asked if there will be helicopters on the large ocean planes of the future, making it possible for them to hover when they reach their destination. Frankly I see little promise in the helicopter. On the other hand, I confess to a growing enthusiasm for the possibilities of using parachutes on planes to lower them slowly in cases of emergency. Size of plane need be no hindrance to very large parachutes, or perhaps several suspending different parts of the machine.

I am inclined to think that the remarkable success of the earth inductor compass in guiding the trans-Atlantic flyers on their course was the most important single item in the list of what they achieved. This type of compass is not especially new in principle. We could not have used it *Continued on page 114*

"WE"—Charles Lindbergh and his single-engine monoplane *Spirit of St. Louis*—which thrilled the world by riding more than 3600 miles from New York to Paris in 33½ hours. This and Chamberlin's record flight to Germany, says Commander Byrd, proved the efficiency of stock planes, and the reliability of navigating instruments.

Lindbergh's Great Partner

Mechanical Marvels of the Monoplane, Engine and Precision Instruments That Carried Him to Fame

By FRANK PARKER STOCKBRIDGE

"WE," SAID Lindbergh. "My plane and I."

The plane first. Right! The courageous young flyer could never have made his magnificent ocean hop without a plane. Planes have flown without a pilot, radio-controlled; one may yet fly pilotless from New York to Paris. But that is another story. This is about Lindbergh's plane.

Give Lindbergh, the man, every ounce of credit for courage, judgment, flying skill, yet his plane and its equipment had to be as good of their kind as he was of his kind. What is it like, then, this last word in airplanes? How does it differ from other planes which previously have tried long-distance flights and failed?

The *Spirit of St. Louis* embodies all that has been learned about airplane design and construction since the Armistice. The war taught aircraft designers a great deal, especially about building fighting planes. But—

No airplane which was in existence at the signing of the Armistice, on November 11, 1918, equipped with any engine which was then in existence, could have made the flight which Lindbergh made.

War demanded high speed, great maneuverability, a high ceiling and power with which to climb to it quickly. Peacetime aviation calls for safety, stability, endurance and reliability, minor considerations in fighting planes intended for short flights at top speed.

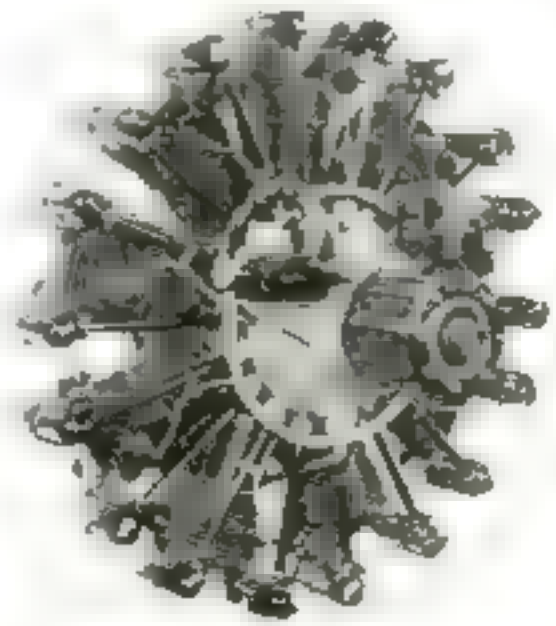
In its elemental design, Lindbergh's plane embodies one lesson learned from war. It is a monoplane.

Driving mechanism of earth inductor compass. Power is generated by a tiny windmill at the top

AMERICAN aviation began with biplanes, and America has stuck consistently to biplanes ever since, until recently. France began with monoplanes. Had it not been for Glenn Curtiss's victory with his biplane, when he won the first international aviation trophy at Rheims, in 1909, American aircraft designers might have considered the monoplane a little more seriously in the early days of the art. But the Curtiss victory was regarded as a triumph of the biplane, regarded as the safer and more stable of the two types and capable, as was demonstrated at Rheims, of even greater speed.

England followed America's lead, in the main, with the result that the great majority of the airplanes used by the Allies in the war were biplanes. But some of the French monoplanes proved their superiority in many respects, and when the war ended students of aviation generally agreed that the one small plane which had given the best account of itself on the Western side, was the German Fokker, designed by a Dutchman from French models.

That stimulated the development of the monoplane after the war, for commercial use. In America only one successful monoplane had been developed in 1919, by Grover Cleveland Loening. Today at least eight of the most widely known makes of airplanes have but one pair of wings. It was a monoplane, the Columbia-Bellanca, which carried Chamberlin and Levine on their record hop to Germany, and which previously established a new world's record for sustained flight. It was in a Fokker monoplane that Commander Byrd crossed the North Pole. All three of the planes that lined up on Long Island in May last, preparing to fly to Paris, were monoplanes. And it was in the smallest of them all, the little Ryan monoplane, that Charlie Lindbergh first flew across.

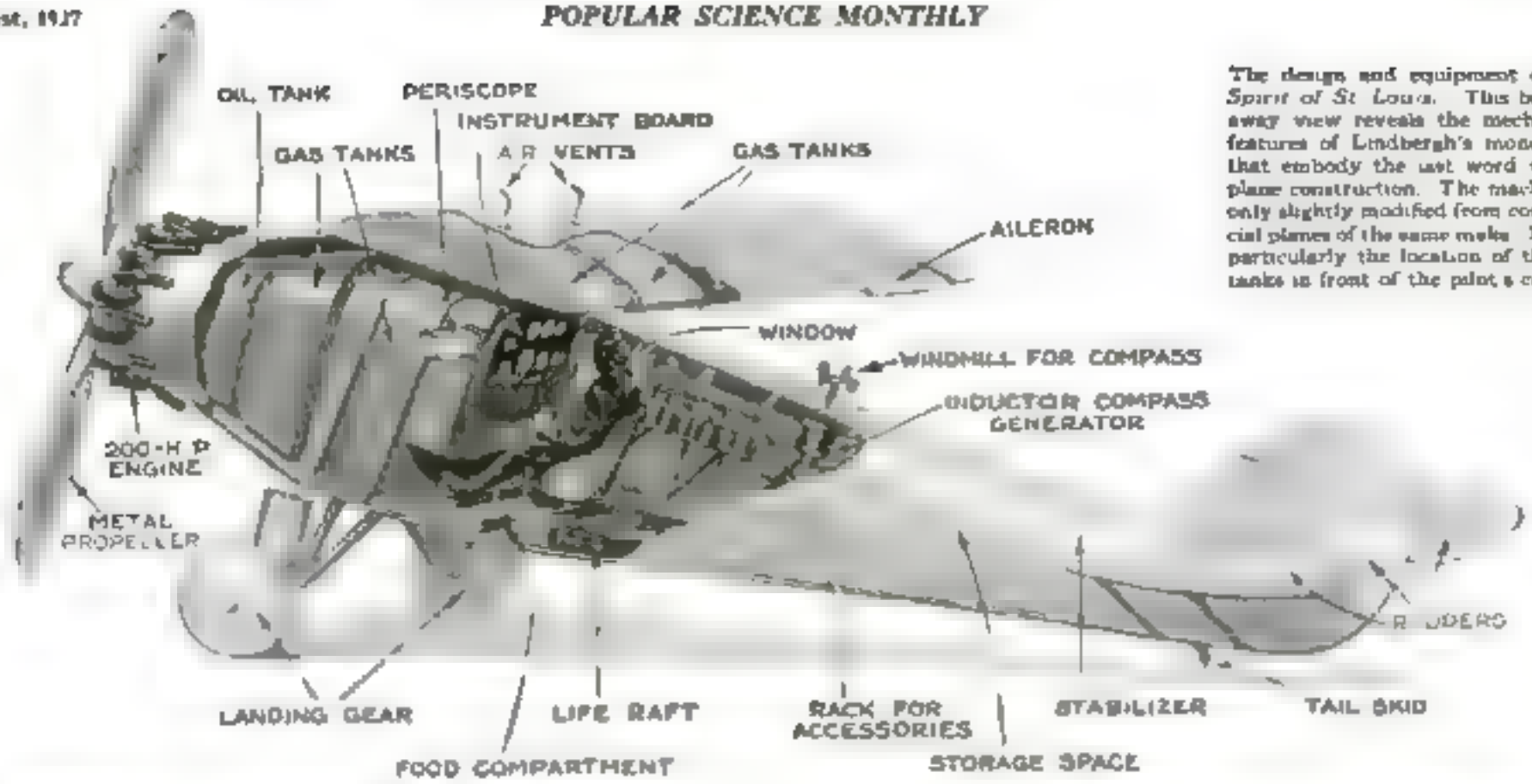


Wright Whirlwind motor which drove the *Spirit of St. Louis* 3647 miles without missing a stroke

In cockpit of the monoplane, Lindbergh, showing the controls and instruments by which he guided his plane from New York to Paris. Behind him is the gasoline tank, and he is seen at the little window of his inclosed cabin

Yet one of the comments which Lindbergh made about his experiences and observations in Europe was an expression of surprise at the greater development of the monoplane in France.

Lindbergh's plane is but slightly modified from the commercial type of the same make which is regularly used in carrying air mail between Los Angeles and Seattle, via San Francisco. It is what is known as



The design and equipment of the *Spirit of St. Louis*. This broken-away view reveals the mechanical features of Lindbergh's monoplane that embody the last word in airplane construction. The machine is only slightly modified from commercial planes of the same make. Notice particularly the location of the gas tanks in front of the pilot's cockpit

a semi-cantilever monoplane, with the wings located above the fuselage. In the commercial plane of this type, the pilot's seat is directly behind the wings, while the compartment for mail, express matter or passengers is under the wings.

The first change made from the standard design was to fill the cargo space with large tanks to hold the 300 extra gallons of gasoline needed to carry the flyer across the Atlantic. The next increase the pilot's cockpit, putting a roof over his head and an entrance door on the right of the fuselage, with a corresponding window on the left. The three regular tanks, which carry 151 gallons of gas, enough for 500 miles, are located between the wings, over the cargo space, and inside the body of the machine, behind the pilot.

THE new location of the gas tanks was chosen for two reasons, first, to put all the weight in front of the pilot so that he would not be crushed between the gas tank and the engine in case of a crash; the second, to reduce the length of the gas line from tank to engine, thereby lessening the danger of the gas line becoming clogged. The longest gas line in Lindbergh's plane is barely two feet.

Four hundred and fifty-two gallons of gasoline, the amount with which Lindbergh started off, weighs somewhat more than a ton and a half, instead of the 750 pounds of mail or passengers which the standard Ryan plane is designed to carry. The extra weight necessitated increasing the lifting area of the wings. Further weight was added not only by the enlarged wings but by the necessity of lengthening the standard fuselage, to counterbalance the shifting of weight forward.

So ten feet was added to the length of the wings, giving them a spread of forty-six feet. That it proved sufficient to lift the initial load of 3,150 pounds with which the *Spirit of St. Louis* started across the Atlantic. As the wings are almost exactly seven feet wide, from front to back, their area is 320 square feet. One pound of sustaining capacity of sixteen pounds to the square foot demonstrated on the Paris flight might easily be exceeded, although the design of the wings of Lindbergh's plane is for speed rather than lift.

The rule in airplane construction is thin wings for speed, thick wings for lift. This plane's wings are only about eight inches through at the thickest point. They are made of spruce ribs shaped to what is known as the "Clark Y" section, held in place by wires, and covered with cotton fabric treated with "dope," a solution of celluloid in acetone and wood strengthens the fabric and keeps it taut.

One interesting departure from standard practice in the wings is the location of the ailerons, the "little wings" which operate to control lateral balance, and are hinged to the after edge of the main wing structure, one on each side. When the plane starts to tip to the right, a slight movement of the control lever or "joy stick" swings the right aileron downward and the left one upward. This reduces the wind pressure on the lower side of the left wing and increases it on the corresponding surface of the right wing, bringing the plane back to an even keel. The ailerons, too, enable the flyer to "bank," the machine in turning, and so avoid side-slips. In Lindbergh's plane the ailerons, instead of being attached to the wings at the extreme ends, where they are usually placed, are cut in about two feet from the wing tips to increase the rigidity of the wings.

THE fuselage, or body, of the plane, is suspended from the wings by wooden struts, streamlined, or shaped to

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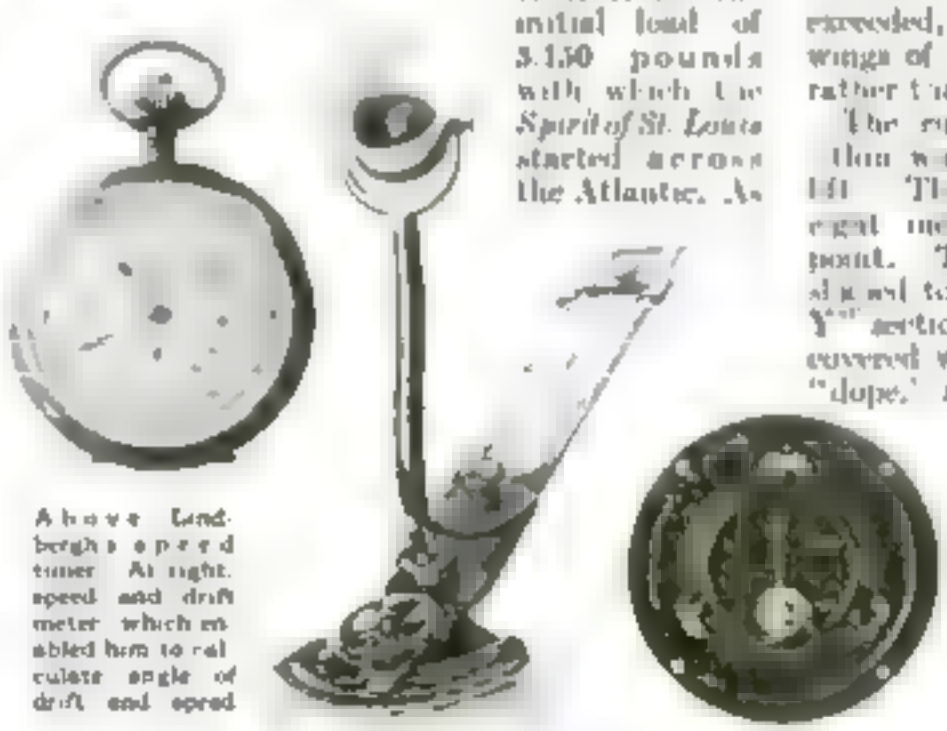
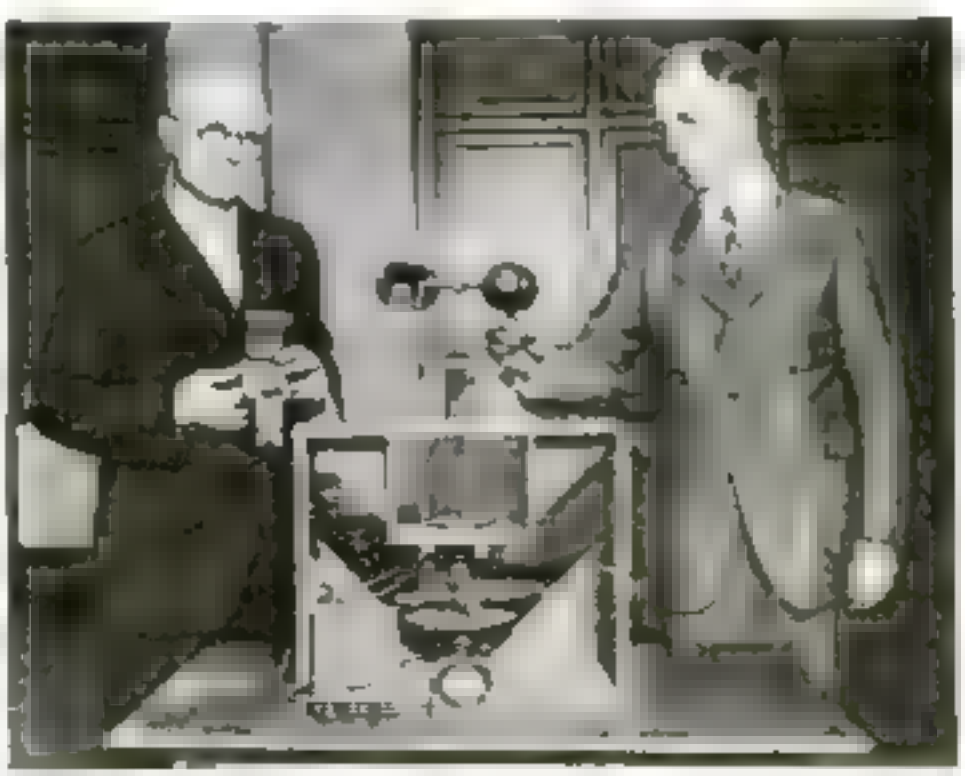
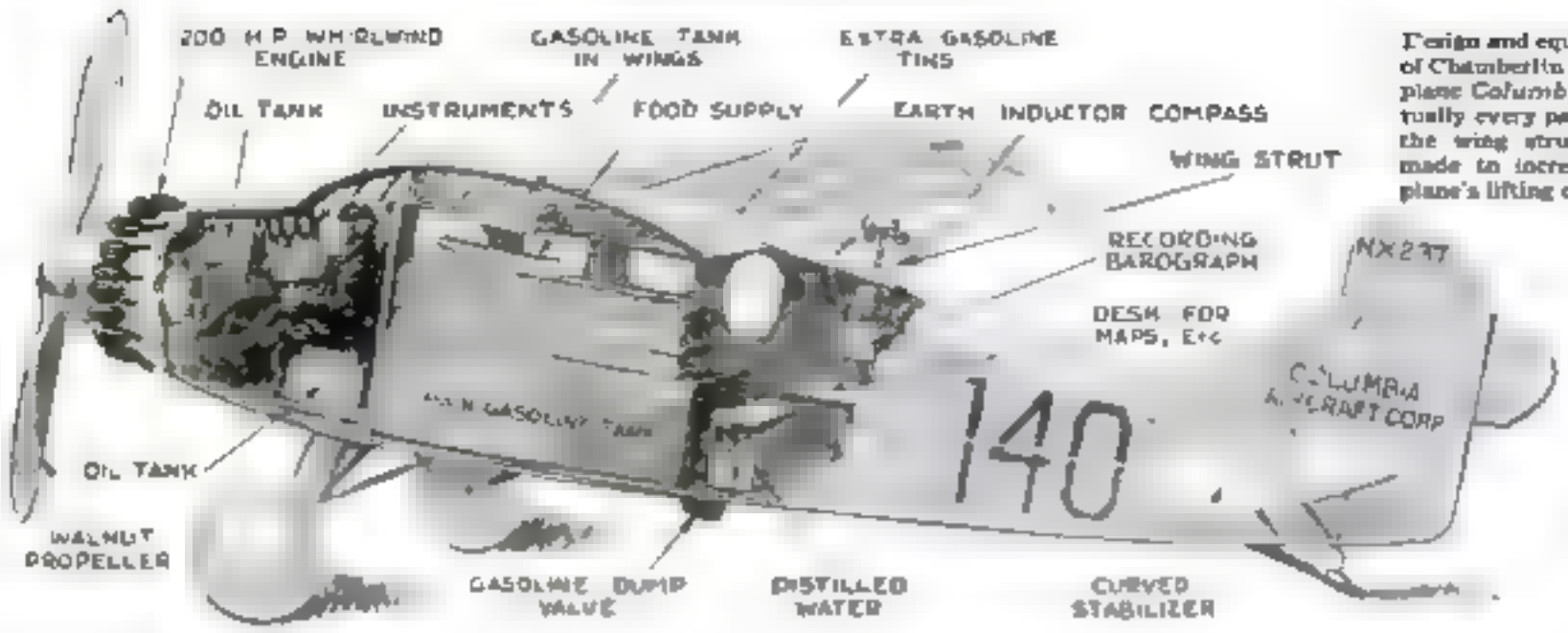


Above, Lindbergh's speed timer. At right, speed and drift meter which enabled him to calculate angle of drift and speed

At extreme right, the indicator of the earth inductor compass. All the way across, Lindbergh watched the little hand on the dial, which told him of any deviation from his course



First model of the earth inductor compass, the invention of Maurice M. Titterington, left, which enabled Lindbergh and the *Spirit of St. Louis* to reach the Irish coast at a point only three miles from the planned course



Design and equipment of Chamberlin's monoplane *Columbia*. Virtually every part even the wing struts, was made to increase the plane's lifting capacity

The First Plane *to* Germany

What Aviation Experts Say About the Atlantic Flights and the Future of Ocean Air Commerce

By
GEORGE LEE DOWD, JR.

ONE minute before Clarence Chamberlin soared aloft in the sturdy Bellanca monoplane *Columbia* for his record-breaking flight from New York to Germany, the first "air passenger" to Europe climbed into the cabin —Charles Levine, backer of the flight. Levine, it is true, "worked his way" across the ocean, for besides the duplicate instruments he watched during the flight, he relieved Chamberlin at the controls, now and then, to give the pilot a wink of sleep.

Nevertheless, while it took a Lindbergh to blaze the first air trail alone, over the Atlantic to France, it remained for Chamberlin, in his flight to Germany, to first give the world a prophetic glimpse of actual passenger travel in an aerial cabin above the ocean.

By the time you read this, there may be other transocean flights, other overseas air passengers. New wonders in aviation are following one another in bewildering succession. What next? What new accomplishments may we expect in the coming weeks and months?

In messages to POPULAR SCIENCE MONTHLY, a number of America's foremost aviation authorities have given us their impressions of the trans-Atlantic flights and their significance to future air travel.

"Where these men have pioneered, others will follow," reads a telegram from Maj. Gen. Mason M. Patrick, Chief of Air Corps, U. S. Army. "Speeds and pay loads will be increased. Ocean air lines will be organized, and ten years will make commercial air traffic over our oceans the rule rather than the exception."

Clarence Chamberlin (left) and Charles Levine (passenger) at the nose of the *Columbia* before hopping off

Vindication of the air-cooled motor for aviation, with the hope of transocean air lines in the future, is the concrete result of the flights, declares Rear Admiral William A. Moffett, U. S. N., Chief of the Bureau of Aeronautics. "Such rapid progress is now being made," he says, "that no one can tell what will happen next. American aeronautics is on its way to even more remarkable successes."

Ocean-going commercial planes and mid-ocean landing places may be built at any time now, believes Wm. P. McCracken, Jr., Assistant Secretary of Commerce for Aeronautics. Their construction awaits only the financial backing that flights such as Lindbergh's and Chamberlin's will stimulate. "What," he asks, "is there to prevent a regular trans-Atlantic air transportation schedule within a period of, say, five years, if only the necessary financial backing can be made available?"

CHAMBERLIN landed at Eisleben, Germany, with his last drop of gasoline gone—in accordance with his announced intention of flying as long as his fuel lasted. Had he been able to re-fuel at some mid-ocean filling station he could have continued indefinitely. "Such facilities are absolutely necessary to make commercial flying on the Atlantic or any other ocean possible," wires E. R. Armstrong, inventor of the 'seadrome," a "floating airplane

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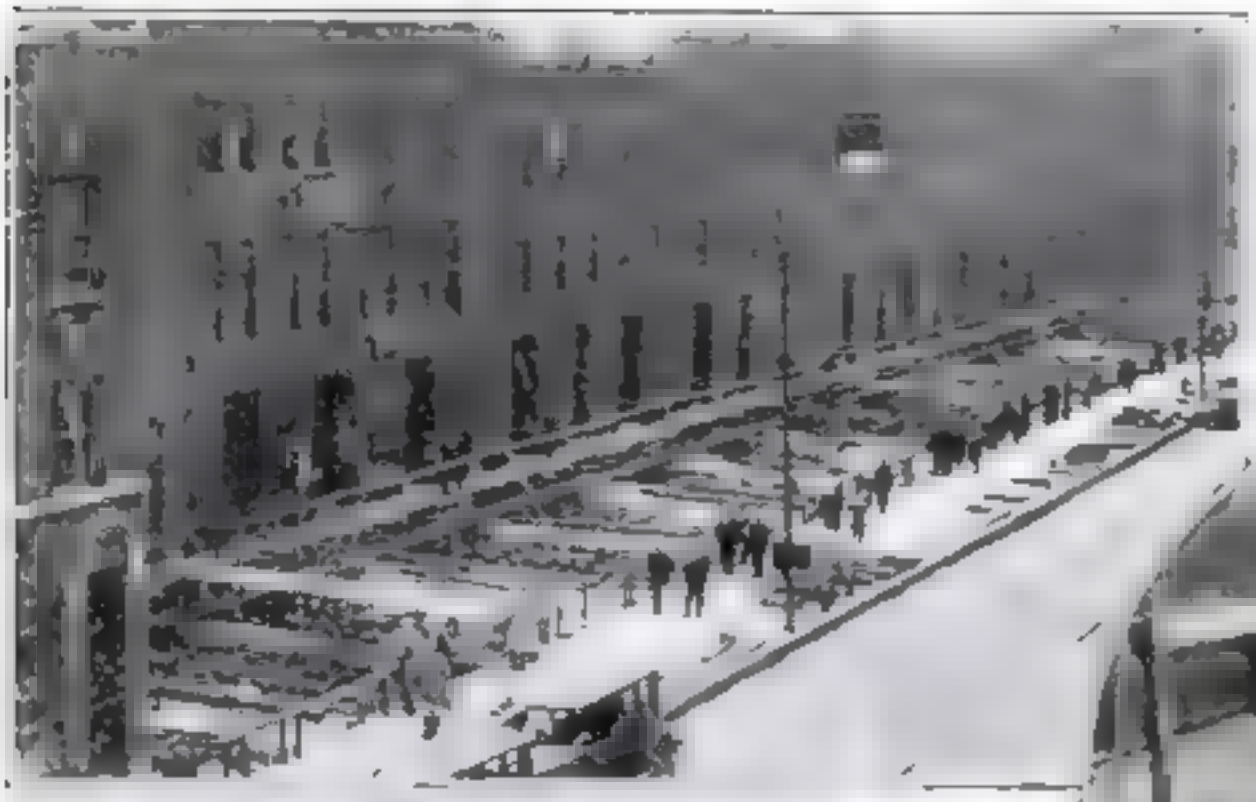
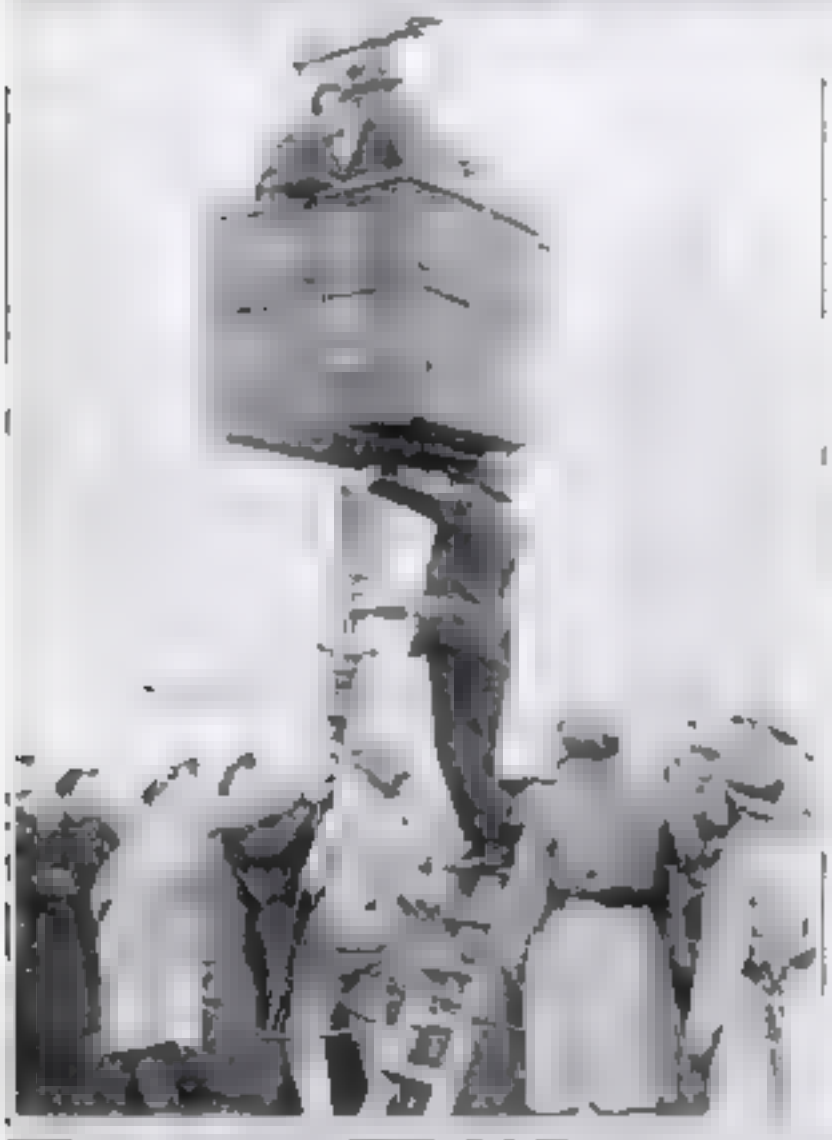




The strangest sight Wendenville ever had seen—Zach and little Gil riding into Main Street in a rickety horseless buggy that belched out clouds of black smoke

Whirling Wheels

A Romance of Inventive Genius and Its Dramatic Struggles to Create the Age of the Automobile

"After some months of experimentation in Wendenville, in the spring of 1896 I had an opportunity to compare the merits of my motor wagon with those of an imported one, and was led to believe that I was on the right track."—Extract from the autobiography of Gilbert W. Herrick

By EDMUND M. LITTELL

Author of "Midge" and "Fire Sky"

Illustrated by B. J. Rosenmeyer

HE IS acclaimed a genius today, the man who wrote those lines, and a genius he most certainly is. But he did not tell what it was that made him a successful genius. There are lots of things that never get into biographies. What is a genius? A dreamer? A fool? Quite often they are called just that. And quite often they stay in that category until the world has passed them by. But Gilbert W. Herrick—well, take a few of those words: "Months of experimentation . . . compare the merits . . . right track." There is a story there—

Wendenville, Michigan, was a quiet little town of about a thousand souls in those days. Wide, tree-shaded streets, a single block of business houses, two churches with steeples rising above the trees, a little frame "depot." No wireless, but the tongue of man was good enough for transmission of the news that a stranger from the city had arrived. Lem Carson, the station agent and livery stable proprietor, started the news after he had taken the young man to the Caswells, and it spread across town like the ripples created by a frog diving into a pond. That was late on a Friday evening of June, '95; too late for Mr. Zach Wenden to make any change in the arrangements. The Caswell house was dark when he got there, and he stood outside combing stubby fingers through his thick black beard. Well, he had told Lem to take the first likely looking boarder there. They needed him worse than anyone else in town, so there he should stay, young man or not. He turned on his heel and went home.

The stranger was a godsend to the Caswells. The husband, a banker from Boston, had been killed by the panic of '93, leaving an estate so involved that there appeared to be no hope of settlement. All they had was the little brick cottage which he had deeded to his wife before his troubles, and they had been waiting weeks for just such an opportunity to keep up appearances. But Mrs. Caswell, gaunt and spinsterish, with straight hair and a cold eye, was not one to express gratitude.

"A mechanic!" she exclaimed when their paying guest had retired to the single upstairs room that had been hurriedly prepared by her eighteen-year-old daughter. "What a state we've come to, compelled to receive a common working man into our home—the Abner Caswells! We never should have left Boston. I told him so the day we left—and we're further away from it now—" her thin lips closed on a sigh; she rocked indignantly in her chair beside the center table lamp.

"An orphan!" was the way her daughter reacted to the additional work in store for her. Not afraid, though. "So young looking, too." There was a dreamy light in her blue eyes. "Looks more like seventeen than twenty-two. So slender and kind of white, and his hair mussed like a boy's—" She had heard her mother subject the newcomer to a cross-examination more searching than a court procedure, she was interested. What she said aloud as she shook down a rope of hair that was auburn silk with fire in it was something quite different.

"Well, he's from the East, at least. That should—"

HER mother snorted. "Springfield! And doesn't know a soul in Boston. Who are the Duryeas in Springfield? No one ever heard of them. If it had not been for his letters I should have turned him out."

"Oh no you wouldn't, mother," softly, with a laugh. "His money is better than none at all."

"Abigail!" It was an oath, and her mother stood up abruptly. "Another remark like that and ... You're more like your father every day. Go to bed this instant! I'll speak to Mr. Wenden about him tomorrow."

Which she did. Not at the blacksmith shop where the giant of a man worked and watched the affairs of the village; that she would never have done. She always managed to meet Zach Wenden casually at the general store or on the walk in front. And the huge man who practiced blacksmithing because he liked it and not because he had to, combed his beard and chuckled.

"He'll do," his great voice rumbled. "He'll do." An endorsement as good as a sterling mark—to any but Mrs. Caswell. Her cold gray eyes grew colder, her thin lips tightened.

"IN BOSTON we would not consider entertaining one who mentioned having 'served time' in Massachusetts," she said. "I think—"

A rumble of a laugh from Zach. "Didn't you read the Jones an' Kinkaid letter? Where it talked about apprenticeship? Well, *that's* 'serving time.' When a man gets his papers from Jones an' Kinkaid, he's a mechanic; none better."

"Well, I shall keep the silver locked up just the same. I collected a month's rent in advance, also. That is the custom in Boston."

"Needn't worry; he'll get along."

"I shan't," with a tightening of lips. "And you may assure James—"

"Looks like a boy maybe, but if you'd heard him standin' up to us this mornin'—" he chuckled reminiscently.

The one she referred to as "James" needed no assurance, what he needed was warning. He was big Zach's youngest son, and was more than casually interested in what went on at the Caswell house. That was why Zach had thought to make a charge. Instead, he took it out in a caution.

"No bullyin', Jim; hear me?" and his stalwart son had growled.

"Naw, I won't thrash him; I'll just ..."

He had met Gil Herrick that morning on Main Street near the corners, and such a contrast! Big Jim, with arms and shoulders that had defeated many a bull calf—and every ambitious man in competition, whether friendly or otherwise, with a mop of black hair and a face as rugged as a boulder—he was a giant indeed, he stood beside his father. Slender Gil Herrick, pale of face, dressed in city clothes, blue-gray eyes looking out from beneath a small-visored cap in a friendly way. What Jim did when he first met the new-comer was to shake hands.

"My name's Jim Wenden," he said bluntly, and stuck out a strong hand.

"Mine's Herrick, Gilbert W.; glad to meet you," —and he took it.

It was an old trick, that tightening of the hand to a bone-crushing point. All the young bloods practiced it—and prepared for it when they shook hands with Jim. It was the kind of horseplay that country men liked, and Gil was a city lad. He suffered. But if Jim expected him to yowl and writhe, hoped to make him a fool before the crowd that stood by watching, he was badly disappointed; for Jim was the one who was fooled. What Gil Herrick did was outside Jim's experience. He declined to yowl; he did not swing a fist; he smiled. Smiled directly up into the black eyes that glittered assuredly above him. Then, in a quiet voice that might have been remarking about the weather:

"You're hurting my hand," he announced.

It was more effective than any yowl or any blow, it surprised the big one so completely that he dropped the hand as though it were a hot coal. Then he laughed shortly, and the gleam in his eyes turned red. His lip curled, his voice drawled, and he tried another tack, while his watching friends grinned silently among themselves.

"Understand you're settlin' here, Gilbert," he said. "What you gonna try to make a livin' at?"

"I'd like to rent that shop." A hand that had been working slowly at his side came up to point at a one-room structure with a single, long-dusty window that stood beside the general store; he was as friendly as ever. "I'm thinking of opening a bicycle and repair shop."

"Repairs?" Jim bristled. "Repair what?"

"Bicycles, guns, sewing machines—anything like that. I—"

"Ain't room for two repair shops in this town; we're doin' all that."

"That's just what I was wondering. You must be related to Mr. Zach Wenden, then. His son, perhaps? I wonder if you'd take me to his shop."

Jim would. That was what he had been sent in to town to do. But he had expected to return with a thoroughly subdued stranger who would have been shown his place. Now—

"Come on," he growled in a most ungracious tone, and swung on his heel to stride away with tremendous steps beneath the trees that shaded East Main. Gil had to run a few steps to catch up with him, and make an effort to keep abreast. Jim crossed three street crossings in surly silence.

"Have you got a wheel?" asked Gil at last. "Maybe I could—"

"Got one. Racer." and Jim was seized with an idea. "Give you a job if we let you open a shop. Put a bigger sprocket on her. If you can."

"Maybe I can when my stuff comes," said Gil. "If you're sure you want it."

"Said I did, didn't I? Ain't that enough?"

"THAT depends. If your sprocket is racing size now I wouldn't change it. Too much of a job to drive a bigger one."

They had come to the outer edge of town, where a lane led from Main Street and ascended a knoll. Jim turned aside on it without warning Gil, who had to turn back and follow him up toward where the weatherbeaten smithy stood.

"Job!" Jim was jeering. "For me?" and he slapped a mighty leg with a huge hand. "I can drive anything."

"For a while, yes," said Gil. "But not for any great distance. It's a matter of... Mr. Wenden? My name is Herrick; Gil Herrick."

They had entered the pungent shadows of the smithy where the huge Zach stood before his forge with one bared arm raised to the bellows handle, and again the stranger dismissed the unimportant for his own affairs. Jim showed how he felt about it by volunteering in a surly voice:

"Says he's gonna open a repair shop. Take money outa our pockets."

Zach wasn't interested in the money part of the shop. He owned many fine acres of farm land, and not a few good properties in town. The reason he stayed a blacksmith was for just such a thing as was presenting itself to him now. But he failed to show it; he released the bellows handle, the leaping cone of fire died down, and he turned a pair of

"Mind if I watch you?" She slipped up onto one end of the bench and watched his slender fingers manipulating a chisel. "You like making things, don't you?"

keen black eyes upon the newcomer who met his gaze steadily.

"That right?" he rumbled, frowning.

"Yes, sir," said Gil with a smile. "The shop part. If—"

He stopped, for the big man had moved away from his forge to a place where the sunlight from outdoors was behind him, and was weighing him from beneath a bush of brows.

EVEN Jim knew when to be silent. A horse whose white rump and switching tail were visible in the rear of the shop, stamped on the splintered planks; it was the only sound. And Zach ignored the city clothes and looked into Gil's eyes; saw the forehead of a dreamer, the strong nose of a doer—and a jaw that said "Maybe."

"H-m-m! Where you from?"

"Springfield. I have some letters."

Zach took them. "Blow up that fire, Jim," he said, and the fire grew again. Promptly:

"Well, Pope bicycles in Wendenvel's," he rumbled when he had leafed the letters through. "Repair shop, too, eh?"

"Yes, sir. I might be able to take some light repair work away from you," with another smile that was neither ingratiating nor brash. "There ought to be lots of guns and sewing machines in a prosperous district like this. And—" he looked about the well-equipped smithy—"maybe I'll have a few jobs for you later on. One or two forgings, and some heavy drilling on that hand press—"

"Oh," and Zach's eyes lifted to that forehead, "inventor?"

"No, not exactly, but I might do a little tinkering some day, and—I worked for the Pope people for a year and when I asked them for an agency they said they had this section, so—"

"Who said anything about competin' with us?" growled Zach. "If you can take jobs away from us, you're welcome. That's what we need around here—competition. Jim, finish up that horse," and he laid aside his leather apron. "I'm takin' this here Gil Herrick around town."

But the warning to his son that lay behind the official acceptance had no effect on him, except to make him worse. Jim had established himself as the strongest young blood in the central portion of southern Michigan. Everyone admitted it, gracefully or otherwise—and stayed away from the Caswells. This one—it made no difference to Jim that Gil was keeping the Caswells alive, he was living there and refusing to bend the knee. How to make him? Easy! Just nag, nag, nag, until a temper was worn through and a pride exploded into flying fists.

JIM had a farm, and he ran it. Zach noticed that since Gil Herrick came to town he ran it better than ever. "Taking his temper out upon it," he surmised with a chuckle into his heavy beard. But Jim always found time to jab at Gil. Either in the post office, where Gil seemed to get considerable mail, or out in front of the repair shop next door, where other people could hear.

"Here's the bicycle kid," Jim would bawl. "How's the inventin' business today? Ain't seen any o' them forgings been done at the shop yet." Or—"Got any flyin' machines today? Thought I might like one. Here's the feller that says I can't beat him with a bigger sprocket."

Gil took that one up. "I didn't say that," he replied quietly. "All I said was that you can't drive a bigger one very far at any speed."

Jim winked at the bystanders. "You don't say so?" he drawled. "Well, s'pose you get me one; I'll show you who I am."

"I know who you are," said Gil with a smile. That smile! It made Jim rage. "But if you want the sprocket I guess I can get it." Gil spoke as one would to a whining child that begged for candy—and that was not easy on Jim. Oh, he had a way, that quiet one!

"Get it!" snapped Jim, and the listeners grinned. "Ten teeth bigger!"

"Ten teeth?" exclaimed Gil, then he shrugged. "All right," he conceded, "it's your money you're throwing away."

After that Jim would have nagged him no matter where he lived, though Gil knew the real reason for his attitude by this time and was careful not to presume on the Caswell family. Mrs. Caswell had taken pains to warn him very early in his life at the house.

It was during the first few days of his residence there. He had asked for a table to use in his room. Anything would do, one of those plain kitchen tables. But they had none, so he suggested that he might make it in the barn, which had been unused since Mr. Caswell's death. He was working there one evening after supper when Abigail slipped out.

"Mind if I watch you?" she said. "The supper dishes are done."

He smiled and said no, and she slipped up onto one end of the bench, and watched his slender fingers manipulating a chisel.

"You like making things, don't you?"

"Yes, I do. It's fun to work with wood once in a while, it smells so clean and feels almost soft after handling iron."

"Have you been an—orphan very long?"

"Four years. They were killed in a runaway," as he bent over his work.

"Oh . . . isn't it—"

"ABIGAIL" from the kitchen door. "You haven't set the bread yet."

"All right! Isn't it a little hard to get started in a new town?"

"Oh no, people are very friendly."

"Abigail!" and the visitor was gone with a flourish of skirts—to present a frown and a question to her mother: "Why did you call me, mother? I was just watching—and you never have any jobs for me when Jim is here."

"Because he is entirely unknown to us," was her mother's uncompromising reply. "He is a boarder, not a member of the family. Remember that, please."

"Or because he hasn't got a farm and money in his own name like Jim? Well, I like him just the—"

"Abigail!"

Gil didn't hear that, but he could take a hint. He stayed in his upstairs room reading and working at all times except when meals were served. Miss Abby, as the townfolk called her, was inspired to talk about him. Even to Jim, which only made matters worse.

"Know we got a good carpenter in town?" Jim drawled one night in the post office part of the general store. "Yes sir! Makes tables 'an' draws funny pictures. Look like buggies, but they ain't no horse onto 'em. What's the matter, can't you draw a horse, Gil?"

Gil looked up from a letter he was reading. "Maybe that's what it is," he said, and frowned. He would have to lock his drawings in his trunk.

Jim guffawed. "Inventor! Tinkerer!—on paper with a pen! Haw-haw! Gimme a pencil, somebody, I'll make you a flyin' machine."

Gil had no reply, unless a sudden departure from the place was one, but he seemed to have a heap of business to do thereafter in the Caswell barn. He had asked for permission to use it, and Mrs. Caswell didn't "see any reason why you shouldn't." That was as near to being friendly to him as she ever got. "If," she added, "you will keep the door locked even when you are inside."

AND shortly after that two heavy cases appeared at the station, to be hauled to the barn by Len Carson. Then Gil picked up an old buggy that had been lying in the weeds back of the blacksmith shop for a year or so, tightened up its wheels until they were as good as new, and swung a sledge for Zach while he made some queer forgings. After that, metallic rappings began to come from inside the barn, to which Gil admitted nobody, and when sputtering, explosive sounds that could be nothing less than an engine of some sort began to be heard—

"Well, well! The little inventor's makin' a flyin' machine!" drawled Jim. "But he's puttin' wheels onto it, ain't he?"

"No, not exactly," was Gil's slow reply. There was a look of defiance in his eyes, his lips were firmly set against what he knew was coming. "I'm putting an engine on wheels. I'm making a motor wagon."

Gil planted one last futile blow before he fainted. Jim Wenden, conqueror, was defeated then and there

"Haw-haw!" Rather flatly, some thought, for this was a poser for Jim. "To beat me an' my high-geared bike, eh? Well——"

"No, not to beat you in any way," interrupted Gil shortly. "I'm not racing you any time, I'm building a motor wagon."

But race him he did, because Jim refused to be evaded. Harvest time came along, and Jim was pressed for time. He had to handle his own farm, after which he had to act as engineer of the threshing outfit that worked around the circle, but there was always time to jab at Gil. Jim had many more friends on his side now, fewer who grinned at his discomfiture.

HERRICK'S BICYCLE AND REPAIR SHOP
POPE BICYCLES
We Repair Anything

That was the sign Gil had painted on his window when he opened his shop, and they had laughed at the vainglorious last one—at first. Then Zach had arranged a demonstration—and a proof of public endorsement. He had called upon Gil to fix the broken knotter on his new-fangled Deering binder. And Gil fixed it. He might be a city man and unacquainted with farm tools, but he knew machines. A nice little tide of business had set in his direction. But now they were saying, "better be fixin' the wheels in his own head, the lunatic!" Such is the fate of a dreamer of dreams.

Then the sprocket came, and Jim got his race. And big Zach Wenden, who had seen a "Maybe" on Gil's jaw slowly altering to a definite "I will," chuckled into his beard.

"I'll put it on myself," said Jim on the night the sprocket arrived. "Anybody crazy enough to try put'n' a engine on to a buggy ain't got sense enough to fit a sprocket. I want my bike to *run!*"

GIL stiffened and there was no smile on his face when he replied. "I'll race you," he said. "Tomorrow—if you're mechanic enough to get a sprocket on that soon. Five miles."

It was a hot race. Straight out the nicely graded road that was the extension of Main Street, with the knoll on which the smithy stood as the judge's stand and big Zach Wenden the judge. Jim in the lead at first, then Gil ahead, to be overtaken at the turn, and a terrific sprint at the finish. Gil won by a few lengths, and when they had dismounted and stood panting beneath the knoll—

Abby had been watching from a favored position beside Zach. Yelling and screaming with the best of them, waving a bouquet of roadside flowers. And when it was all over, she slid down the bank, wormed through the crowd, and presented a somewhat bedraggled bunch of flowers to Gil.

"For the winner," she cried gaily

(Continued on page 100)

On *the* Sea *in a* Cable Ship

Thrills and Perils of the Men Who Lay and Repair the Slender Ropes Linking Continents

By EDGAR C. WHEELER

IT WAS a black evening in mid-Atlantic. Ugly combers pounded and tossed the cable ship *Colonia*, 7981 tons, as she plowed along a bee line between two continents.

Coiled in a huge tank in her hold, a black snake of cable spun smoothly around a spindle. Inch-thick, the snake writhed upward, crawled over a drum at the stern, and slipped into the cold sea.

Every man of the crew of 150 was at his post, nerves keyed; for on this threatening night miles of water lay below the cable ship's keel, and a four-ton pull from the depths strained at the slender rope of copper and steel destined to link two worlds. One hitch in the coiling mechanism, one kink in the moving cable, and the metal rope would become a black snake indeed, its coils twisted, hissing and thrashing, carrying death and disaster to everything in its path.

On deck men watched the cable as it slid over the drum into the blackness. In the testing room an electrician plotted a vibrating spot of light from a mirror galvanometer that signaled unbroken communication with the shore a thousand miles away. In the drum room an engineer stood with eyes glued on the scale of a dynamometer which told of the strain the cable was bearing. Eighty hundred-weights now ... ninety ... a hundred ...

From below came an agonized cry:

"My God, she's snagged!"

Down in the hold, sweating men stood helpless with horror. The coils were rising in a tangled mass! Broken cable, wrecked machinery mangled bodies—they saw too well what it meant. An instant, fraught with suspense—then a form leaped high into the air. It was one of the crew, sharper witted or more daring than the rest. His hands caught at the snarl and clung, as it dragged him upward, swiftly. He tore furiously at the knot. A moment more and the mass would reach the deck, carrying destruction. The man was winning. He had won! Not a second too soon, the writhing thing straightened out to clear the drum.

Yet even as it did so, a sudden twist loosened the man's hold, pitching him to the floor of the tank with a sickening thud. Broken and maimed, he was, but his bravery had saved the lives of companions. And it had saved the cable.

That true incident was typical of the hazards that fall to the lot of the hardy men who lay and repair the thousands of miles of ocean cable that stretch from country to country. Among northern icebergs, in tropical seas, in fair weather and foul, these men sail on a continual round of adventure, that the world may be joined in swift and unbroken communication. So effectively do they perform their task, aided by marvelous instruments of science, that experts predict we shall soon send cablegrams to any part of the globe as cheaply and as often as we now send letters. Today 400,000 miles of cable lie on the ocean floor—enough to girdle the world nearly seventeen times! And fifty-three cable ships are operating on the seven seas, to maintain every foot of it in perfect working order. It is a hazardous job, despite the fact that cable work has developed into an exact science since the time sixty-odd years ago, when Cyrus Field finally succeeded in stretching the first slender cable across the Atlantic.

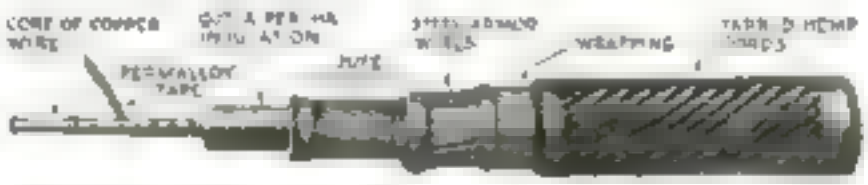
Imagine yourself, for instance, aboard the *Colonia*, one of the two largest cable ships at present embarking on a cable-laying expedition. Greater than some ocean liners she is, 500 feet long, fifty-six feet in beam, and of unusually sturdy construction. She carries a mighty load—nearly 4,000 nautical miles of steel-armored cable weighing, some 8,500 tons, contained in four great circular tanks.

As you prowl on deck, men are coiling the cable in the tanks, winding it on the spindles with infinite care and inserting lath between the coils. This task, you learn, is fully as important as the actual laying of the cable, for the slightest error may cause irreparable damage later.

The cable itself, you discover, is a marvel of electrical efficiency and engineering skill. It is the new high-speed undersea conductor called permalloy cable. Through it, messages can be crowded at the amazing speed of 2500 letters a minute; eight messages at once in each direction. This is ten times as fast as the best previous cable, and more than forty times the capacity of Cyrus Field's first cable, with its sixty letters a minute.

The secret is a thin, narrow tape of permalloy metal, a mixture of nickel and iron, wound about the central core of copper

Hauling up a deep-sea cable for repairs. Caught by a grappling hook the slender rope has been raised to the ship. Two men along on board a chain fasten stoppers to it. When the cable is cut for testing, these stoppers prevent the severed ends from running back into the sea



Construction of the new high-speed permalloy cable, across which messages now rush at the rate of 2500 letters a minute. Its secret is the thin layer of permalloy tape, which keeps signals from jumbling

The final splice—a real thrill to the cable repairmen, for it marks the culmination of his job after the fault in the line has been found. The two ends of the cable are soldered and bound together again

that carries the electric current. This tape has magnetic qualities which keep the signals from blurring or jumbling. About the core and the tape is a thick covering of gutta percha insulation to keep the current from escaping. Then comes a wrapping of jute to cushion the wires. On top of that is a sheathing armor of steel wires. Over all is a wrapping of tarred hemp cords. The whole cable is an inch thick. On the shore ends, where it is likely to beat against rock and reef more steel armor is added, until the cable is thicker than a man's arm.

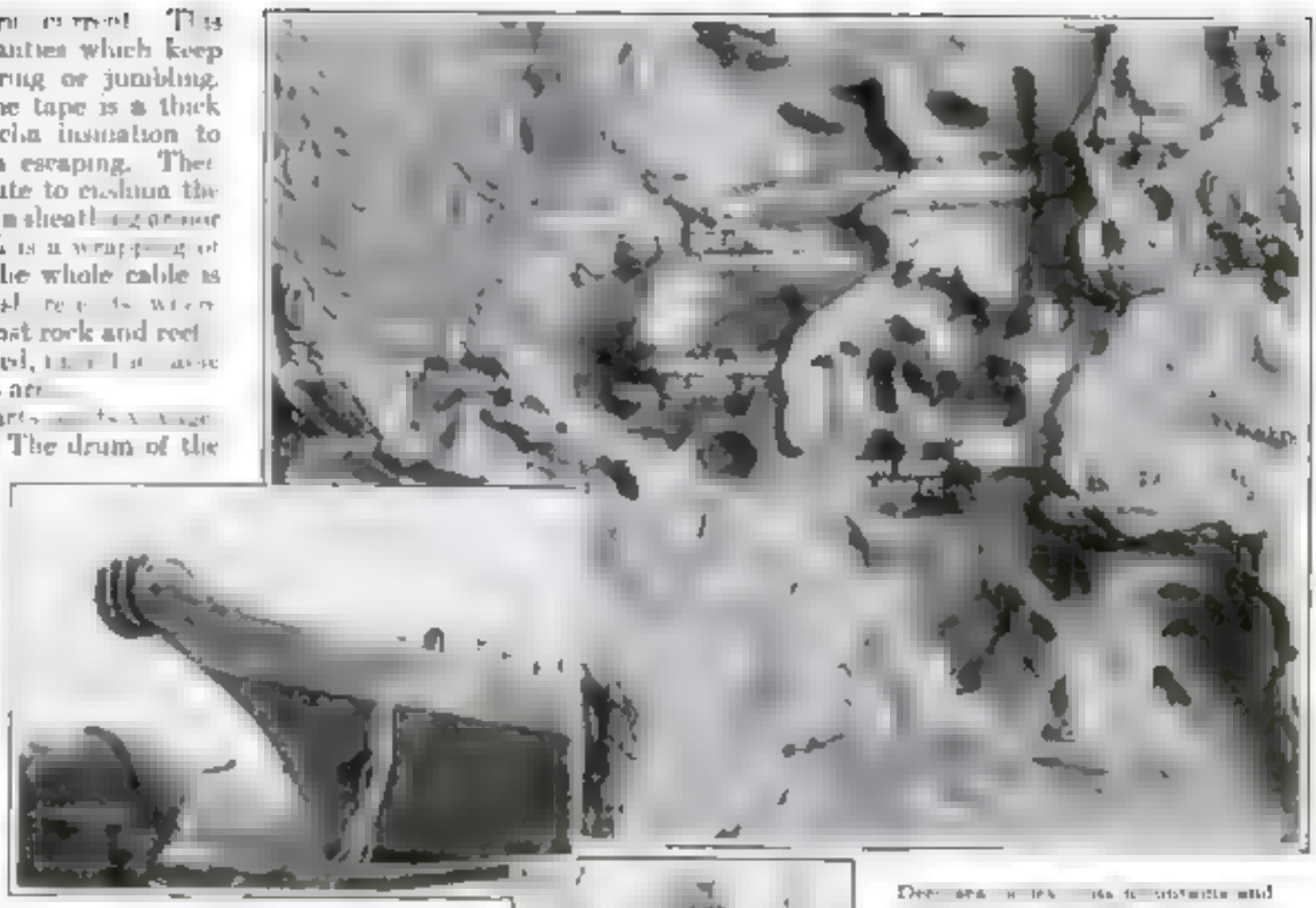
And now the ship starts out, paying out as it goes. The drum of the paying-out machine is fitted with brakes that govern its speed. From there the cable passes under the wheel of a dynamometer which records the strain upon it, then, dragged by its own weight out over a pulley or sheave at the stern of the ship, it drops into the depths of the ocean.

Down in the tank, men watch the black line whip round and round its spindle. At eight knots, ordinary laying speed, it makes the complete circuit of the tank every [illegible] and with each circuit a man [illegible] to watch the uncoiling [illegible] rope jumper. One moment's [illegible] may mean being caught in the [illegible].

Meanwhile, engineers on deck are constantly on watch. Although the course of the cable has been surveyed in advance the ship must "feel its way." For the ocean bed is not a level floor, but broken by lofty peaks, high plateaus, canyons, and valleys known as "deeps." The greatest known depth is more than five miles; the Atlantic floor drops, in places, more than four miles.

The cable must not sink into one of these vast holes, lest it snap of its own weight. Nor must it chafe precipitous slopes, to be cut against jagged ledges.

To detect these hazards, the ship is equipped with ingenious devices. The sense of the dynamometer instantly makes known the presence of a deep by recording increased strain on the cable. In addition to this, careful measurements are made at intervals of a few miles by



Above, odd-shaped [illegible] over the [illegible] sheaves [illegible] over which the cable is [illegible] when [illegible] made [illegible] and fed into the stern

Right, a cable ship [illegible] the [illegible] the ship is over a deep

Deep-sea [illegible] instruments and valves which [illegible] will [illegible] the [illegible] Western [illegible] Atlantic [illegible]

a [illegible] which also takes [illegible] of the sea at the bottom. This consists of a weight attached to a coil of piano wire miles long. When the weight hits the bottom, the contact springs a trigger, releasing a small dredging attachment that brings up soil. Harmful mineral deposits or submarine volcanoes that might injure the cable are detected in this way.

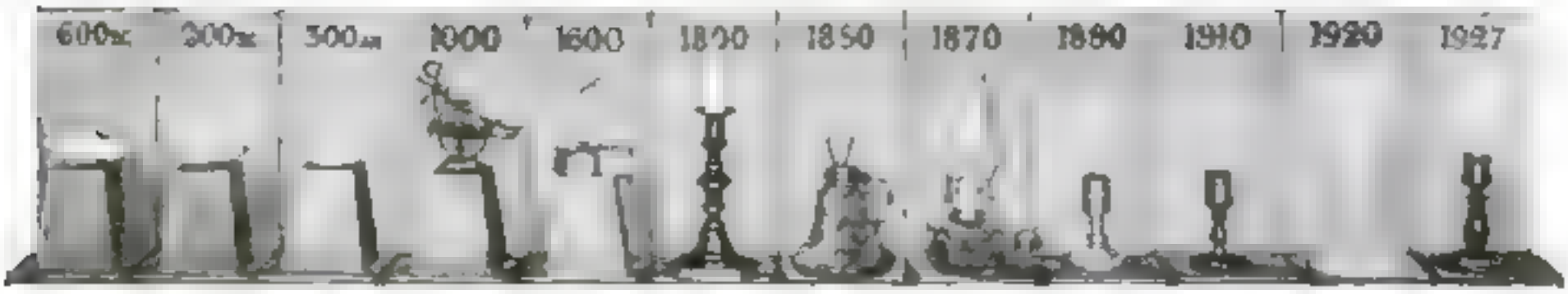
Still another instrument is a sonic depth finder which determines the depth by measuring the time required for sound to travel from the keel of the ship to the sea bottom and echo back again.

Occasionally a sharp detour from the charted course is necessary, as when the Colonia, laying the high-speed New York-Azores cable two years ago, discovered that her course lay directly over the top of an undersea mountain seven thousand feet high! Mostly, though, once the cable ship has started laying her line, she steams ahead for the other end. Nothing short of a hurricane will stop her, and when that happens there is only one thing to do—cut the cable, attach a buoy and throw it overboard. Returning after the storm, the line can be picked up and spliced. The success of any cable-laying job depends largely on the sensitive mirror galvanometer in the testing room. There a tiny spot of light indicates constant electrical connection with the shore. At specified intervals, if all is well, the light makes a sudden leap. Should the spot leap at any other time, something is wrong along the line. Possibly the laid cable will have to be reeled in until the flaw is located.

As the ship approaches land, the laying becomes more dangerous. Coastwise shipping, reefs, submerged wrecks, and carelessly

(Continued on page 180)

Landing the New York-Azores cable at Rockaway Beach, N. Y., through heavy breakers, was a hazardous task. The cable was hauled in, slowly and carefully, supported by barrels every thirty feet along its length



Steps in the progress of illumination in 3500 years. Left to right: saucer lamp (vegetable oil); early pottery lamp, vegetable oil; decorated pottery lamp, vegetable oil; bronze lamp (olive oil); "Betty" lamp (grease brought to America by Puritans); candle; "Camphene" lamp; coal oil lamp; carbon lamp, first Mazda lamp; white Mazda lamp; new standard lamp with inside frosted bulb

A $10,000,000 "Accident"

The 'phone rang, and Marvin Pipkin found the secret of better lights for 16,000,000 homes

By KENNETH WILCOX PAYNE

BUT for lamps, we should spend two thirds of our lives in darkness. For centuries men have fought for more and better light. The story of the Edisons and Langmuirs who have turned night into day forms one of the great romances of invention. And the latest episode, related here by Mr. Payne, is a most dramatic climax. By perfecting inside frosted lamps, Dr. Pipkin has provided bulbs that are almost shock proof; he has relieved eye strain with glareless light, and he has given us ten to fifteen percent more light for our money.

WHEN Dr. Marvin Pipkin stood six electric light bulbs on a Cleveland conference room table not long ago and flipped them over with a careless gesture, he started something that is saving his fellow citizens about $10,000,000 a year.

To a layman his experiment would have seemed of trifling interest. He had a company come into the conference room with a few insignificant frosted bulbs, grayish in color. They were frosted on the inside, instead of on the outside—but what of that?

Well, here's what of that.

Dr. Pipkin had done what experts has been laughing at for twenty years as an impossibility.

He had brought about simplified manufacturing in an industry that puts 300,000,000 lamps annually into our homes and shops.

He had given cheaper and better light to 16,000,000 American families.

He had earned for himself the Charles A. Coffin award for meritorious service, and for his company he had won the praise of Herbert Hoover and the Department of Commerce because of another significant step in the national campaign against waste in industry.

In fact, Dr. Pipkin had rounded out the half-century of lighting progress since Edison's first crude carbon lamp by perfecting what is said to be the most generally advantageous light source yet devised by man.

All of which Dr. Pipkin accomplished thanks to a love affair, an annoying telephone call, an accident to a half-finished bulb—plus his own persistence and chemical skill.

Knowing nothing about this, a short time ago when I dropped into an electrical supply store, I was exasperated when the dealer told me he couldn't sell me the particular round, frosted bulb I sought. He said he wasn't carrying that kind, and their sale was being discouraged. He tried to sell me, instead, a pearly-gray, balloon-shaped lamp.

Doubtless many other consumers have had similar experiences lately. We used to be able to choose from nearly half a hundred different kinds of electric lamps. Now, my dealer said, we are being narrowed down to a standardized line—six sizes, all of the same shape and finish. But he insisted that the only limitation upon our freedom as consumers was a limitation to our privilege of being extravagant.

FOR he added that the new standard lamps would cost me only twenty-three to forty cents apiece, a reduction of more than forty-four percent in recent years. Also that the new lamp was so rugged I could almost let the baby drop it downstairs; and that it would give me more light for the current consumed, last longer, and be much better for the family's eyesight than the older lamps.

Considering that 68,000,000 of us in this country use electric lighting, I should have been impressed by these advantages, but somehow I wasn't—until I met Marvin Pipkin, at Nela Park, and learned of the technical achievement that gave birth to these inside-frosted bulbs.

Nela Park is the headquarters of the National Lamp Works on the heights back of East Cleveland, Ohio. If you are puzzled by some tricky problem in lighting home, shop, school or street, they will solve it for you there. The chances are they have already solved it and are only waiting for you to come and get the answer, as 12,000 visitors from all parts of the world do every year.

AS ONE of them phrased it, "Nela Park is a place where the light of tomorrow shines today." Its staff of engineers and research specialists have contributed millions of dollars to the profits of American business, and incalculable comfort and pleasure to community life. Fifty years ago the candle was still the mainstay of our fight against the darkness in which two thirds of our lives would be spent but for artificial light. Now electric light is vastly cheaper than candlelight; it gives us twenty-one times more light for our money than did Edison's first lamps. And no one institution has made greater contribution in recent years to illuminating progress than Nela Park.

It was with one of the executives of this organization that I discussed the subject of the standardized lamps.

"About twenty years ago," he said, "I was one of several who had a brilliant idea. I was just out of college, on my toes to make a hit with my employers in the lamp business. I told them—what everybody knew—that the frosted lamp gave better light than the clear bulb, but that outside-frosted lamps pick up dirt rapidly and are almost impossible to clean. 'So, I suggested, 'let's confer a blessing upon electric light users by frosting our lamps on the inside.'

"My superiors smiled indulgently, agreed that it was a splendid idea. 'Why

don't you look into it?' they inquired. I did. I found that other bright minds had set on the same notion. I found further that it was quite possible to frost a bulb on the inside. The only trouble was that a lamp thus frosted became as fragile as a blown bird's-egg.

"Since then many another newcomer has had the same idea and the same sad awakening. They all gave it up. Sergeant Marvin Pipkin, late of the Chemical Warfare Service, began playing with the idea when he joined our staff after the Armistice. But he didn't give it up. He seems to have the notion that impossible things are just the things which can be done.

"DR. PIPKIN had studied at Alabama Polytechnical Institute, after a youth in Florida. Chemical engineering was his specialty, but road building was his first job. During the war he enlisted at Jacksonville, and because of his special chemical knowledge was sent to Nela Park, where Uncle Sam was developing defensive methods against German gas.

"The Armistice left him out of his job with Uncle Sam, but blest with a Cleveland girl for a wife. He explained to her the charms of home life in Florida, and she countered with a defense of Cleveland. So they stayed in Cleveland. If electric lamps are cheaper and better today than anybody ever thought they could be, remember that part of the credit goes to Mrs. Pipkin, whose preference for the old home town kept her husband at his task.

"When he inquired if there wasn't something he could do around the lamp laboratories, somebody proposed that he try his hand at inside frosting just to keep him from getting occupied.

"That was back in 1919. You'd better ask him about the rest of the story.

I FOUND Dr. Pipkin on the top floor of one of the big buildings, in a laboratory cluttered with jars of chemicals, and half snowed under with bulbs of all shapes and sizes and in various stages of breakage.

"Val apropos of breakage," Dr. Pipkin remarked, "it was really our strict policy against wasting bulbs even in experiments that helped in the discovery of inside frosting as a commercially practical scheme.

"You are familiar with the brilliant achievements that have made the modern lamp possible. Dr. W. D. Coolidge changed tungsten wire from a very brittle substance into one of the strongest metals known, and so made possible tungsten filaments, giving eight times as much light for the current consumed as the old carbon filaments. Edison, in his early experiments, tried to use nitrogen-filled bulbs, and decided that an electric lamp must have nothing at all in it to be successful. Now, thanks to Dr. Irving Langmuir, we know how to put certain inert gases back into the bulb—with the result that the filament can be heated to higher temperatures without breaking.

Countless improvements such as these resulted in flooding the market with a vast variety of electric bulbs, and at last the manufacturers appointed a committee to design a new simplified standard lamp which would overcome, if possible, the growing confusion of styles and resultant inefficiency in manufacture.

"A method of exhausting the lamp through the neck had done away with the old pointed tip at the spot where the air had been taken out. A coiled filament had been perfected to replace the straight filament. In short, the lamp industry was at a point where an efficient standard lamp could be designed; but to hit on a standard finish seemed impossible.

"Everybody agreed that the new lamp should emit as much light as a clear glass bulb, but should diffuse it and prevent glare, as does a frosted bulb. However, a bulb frosted on the outside not only collects dirt, but refracts some of the light inward. If we could only etch bulbs on the inside, we would have a smooth outside surface and we knew that the inside frosting would waste by refraction only a negligible proportion of the light.

"Still, when I was fussing around with inside frosting experiments, back in 1919, everybody laughed at me, and kept calling me off to tackle something 'more practical.' They told me about the manufacturer who had contracted with the railroads to supply 50,000 inside frosted bulbs, and had begged off on his contract when he found he had fifty percent breakage in his product. Inside frosting was an exploded dream.

"However, I kept experimenting with various acids, and types of glass, and different shapes of bulb. And when this matter of standardization came up I went at the problem in earnest.

"YOU see, after a bulb is blown it can be frosted on the inside by etching with a strong solution of hydrofluoric acid. I knew that after etching a bulb, I could pour in a weaker solution and allow it to stand for a time, with the result that the fine grained texture originally etched in the inner surface would be eaten away and the bulb would be clear glass again, ready to be used over in new experiments.

I often cleaned bulbs this way, in order not to waste them. One day I had just poured a cleaning solution into a lamp on my desk when a telephone call interrupted me. In answering the phone I accidentally tipped the bulb over and spilled the acid out before it had had time to clean off the inside etching.

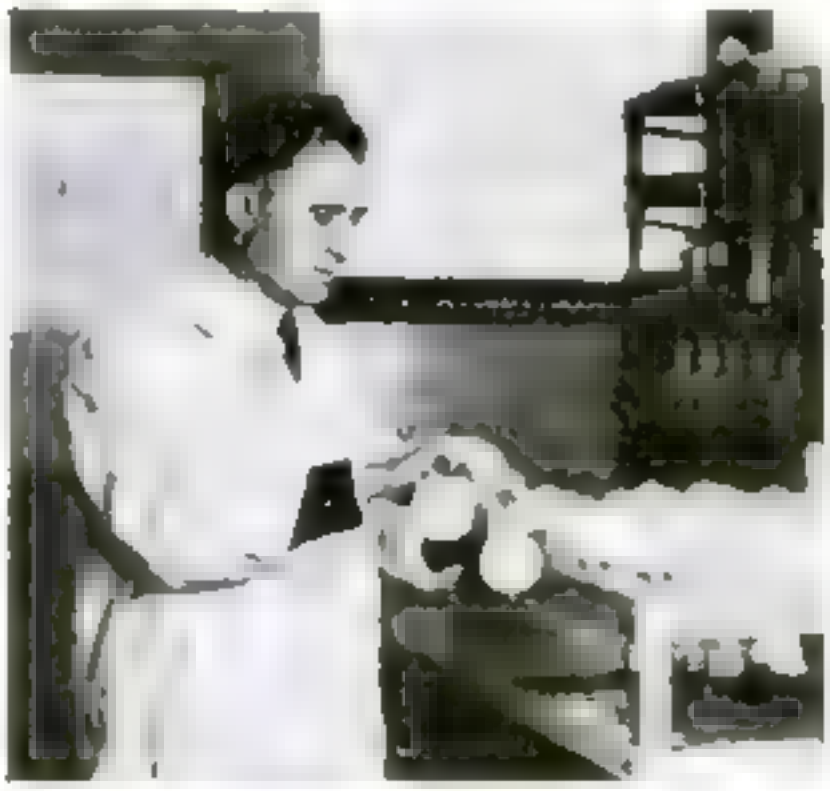
"Later, when I returned to my experiment I was careless enough, to drop the inside-frosted and half-cleaned bulb onto the floor. By all rights it should have smashed to pieces. Even a clear glass bulb might not have stood the drop. But this I knew: only very fragile inside frosted bulb just bumped on the floor and rolled under the desk intact. And that sad thing was to my recovery.

Thereafter, Dr. Pipkin treated a few more bulbs in the same way. Then he took them before a skeptical audience, stood them in a row on a table, and tipped them over. The first one smashed to pieces, as everybody expected. But the next three didn't break and the last two Dr. Pipkin nonchalantly knocked to the floor where they bounced unshattered, in violation of tradition.

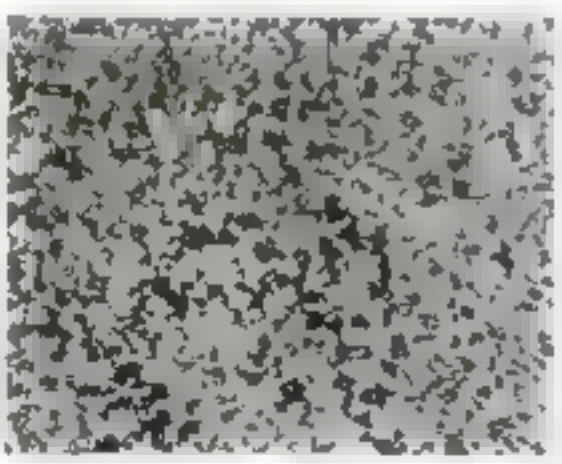
The skeptical smiles of the audience vanished. In amazement they asked the inventor what the secret of his accomplishment was. Modestly he admitted that he hadn't the slightest idea.

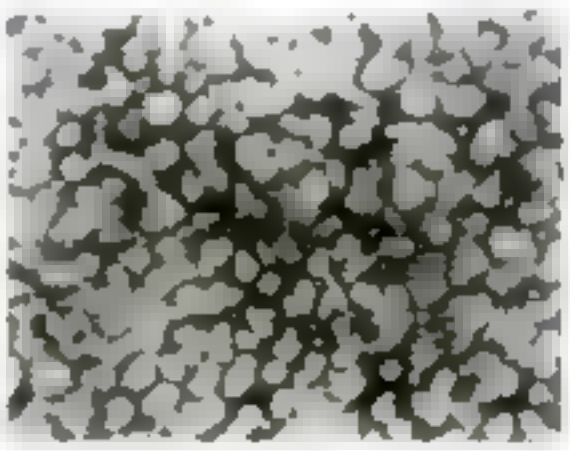
"But I do know the exact procedure that produced these unbreakable bulbs," he added. "I can make more like them." He did, and now his process is being duplicated in the manufacture of several hundred million bulbs a year.

"So you see," Dr. Pipkin told me, "it was all just a little accident."



Dr. Marvin Pipkin in his laboratory at Nela Park, O. On the table in the rack are seen the long neck bulbs which the lamps are originally blown before frosting





After the first etching with strong acid, the inside frosting of the new lamp bulb has the texture shown at the left and the glass is extremely fragile. After treatment with a weaker solution of the same acid, the surfaces are rounded and consequently strengthened

Each *of* Us *Has* 40 Slaves

WE AMERICANS have grown so accustomed to pressing buttons and pulling levers, that few of us realize the vast power of the mechanical servants that do our bidding. Did you know, for example, that ten horsepower is available to every person in the United States? Or that our automobiles alone are nearly twice as powerful as all the people in the world? The following article discusses in a new and fascinating way how mechanical power is lightening our labor, relieving our drudgery, and adding to our comfort and happiness.

Drawing by I. Dickson

By
ROBERT E. MARTIN

NEVER before in history have any people been able to perform such tasks as the people of the United States are accomplishing today. Yet there are other nations larger than ours. The population of China is four times as great. The population of India is triple our own. Yet no nation equals the United States in the amount of work done, or in the comforts and conveniences of life.

The reason is simple. We can do more work than any other nation, because we have developed more mechanical power. Work is being performed more and more by machinery. "Laborers," in the old sense, are to be found far less commonly than in other countries—less frequently, too, than in this country a few years ago. The time is almost here when no one will earn his bread "by the sweat of his brow."

For every person in the United States there is between eight and ten developed mechanical horsepower. A sturdy man is capable of developing about one fourth of one horsepower during sustained labor. Thus, the strength of each of us is multiplied by our machines nearly forty times.

About one billion horsepower is at work in our country, exclusive of our own physical energy and that of draft animals. Our automobiles alone are nearly twice as powerful as all the people in the world! Steam locomotives on American railroads [illegible] all the people of North America, South America, and Africa. Our developed waterpower exceeds the strength of the people of England, Ireland, Scotland, and Wales, although we have developed only twenty percent of the power of our streams. In fact, if our windmills were to run simultaneously in a breeze blowing twenty miles an hour, they alone would surpass the man power of Turkey in Europe.

It is impossible to estimate exactly the amount of power we actually have at work. Our automobiles supply between 550 and 600 million horsepower; locomotives fifty-five million; electric plants, more than twenty million; factories, exclusive of those that buy electricity, twenty-five million. Small stationary engines, traction engines, steam shovels, motor boats, steamships, small water power installations, and many other sources of power bring the total to about one billion. And engineers are looking forward to a time when this will seem but a trifle. Furthermore, so long as our sources of power continue to grow, our incomes, too, will grow, and our scale of living will continue to improve proportionately.

HOW can we visualize one billion horsepower?

If we had slaves doing the work of our power plants, we would require about forty slaves for each of us—a total of [illegible] and a half times as many people as there are in the world! Obviously there would be no room for so many people to live, for it would mean a population of 1000 to each square mile, in addition to the present population, which is about thirty-six to the square mile.

BUT even if we could take care of so many slaves, they could not accomplish the work now being done. They would have enough strength, but could not apply it uniformly, as an engine can. A group of twenty men may be rated at five horsepower, yet they could not do the work of a five horsepower stationary engine. A hundred men could not propel a light automobile at thirty miles an hour all day, although they might equal such an automobile's horsepower. A sturdy man can strike a heavier blow with a hammer than can a pneumatic riveting hammer, yet ten men with riveting hammers can do far more work on a steel structure than could a hundred men with sledges. Thus a riveting hammer, which is a very small machine, multiplies one man by ten.

So vast is the developed power in our country that could the entire state of Connecticut be excavated to a depth of four feet and placed upon a huge elevator, the power of the country could raise the load to the top of a six-story building in an hour. If all

(Continued on page 141)

Timothy, its pollen causes nine tenths of spring hay fever in Eastern states

Horses often cause hay fever. Dandruff from their coats is blamed

Ragweeds, responsible for most fall hay fever. Less than a mile away, eight wide varieties

Hope *for* Hay Fever Victims

Don't blame the goldenrod; it may be your feather pillow or woolen blankets—Surprising new facts about the malady which causes a million to suffer

By NORMAN C. McLOUD

ONE of my neighbors had suffered from hay fever for twenty-two years. Each fall had brought the annual attack with such regularity that he looked upon it as having the certainty of taxes. For five years he had availed himself of what is known as preseasonal treatment, or advance inoculations of the extract of weed pollens to which his nostrils were particularly sensitive. The theoretical immunization seemed to do him little or no good.

Last year he tried a new deal—something entirely new to the medical world. The ensuing season was the best he has experienced since his hay fever started. In the past he had been laid low from autumn journeys, because of the irritating effect of railway smoke and dust. In 1926 he was able to take a trip of a thousand miles without discomfort. He passed the entire season with complete freedom from asthma, which had been his perennial foe, and with almost perfect immunity from hay fever itself.

My neighbor's case is presented with no purpose to jump at the conclusion that the long-sought specific for hay fever has been discovered. However, the new treatment is believed to mark definite progress towards the control of hay fever which today claims more than a million victims in the United States. It resulted from successful scientific attempts to isolate the protein and albumin contained in the pollen of ragweed, the dust which produces most of America's autumnal hay fever. The achievement came about through the research of Dr. Harry S. Benton, associate professor of hygiene and preventive medicine at Georgetown University, Washington, D. C., in collaboration with D. Breese Jones and Frank A. Csonka, of the U. S. Bureau of Chemistry.

The object of the research was to determine the precise chemical portion of the pollen which provokes hay fever, and to prevent the disease through inoculations with the portion which affects the individual sufferer. Similar study has been made with pollen of timothy grass, which shares with orchard grass the responsibility for most summer cases of hay fever.

In their sortie against the autumn ailment the scientists have used the proteose and albumin portions of the ragweed pollen with marked success. Their experience shows that some patients are sensitive to both fractions, but that most of them respond to the proteose alone. This indicates that the proteins of the pollen are the cause of their suffering when inhaled into the nostrils.

In the matter of summer attacks of hay fever the scientists have isolated four proteose fractions of timothy, in pure form. Patients inoculated with these have enjoyed almost complete freedom from symptoms of the disease.

THE separation of the pollen into its individual elements constitutes a significant change from previous methods in which the physicians worked with the entire protein content of offending vegetation. In the case of my neighbor, the season's relief was achieved through arm injections of the proteose and albumin fractions of the pollen of ragweed, which is held responsible for autumnal hay fever.

Hay fever is a catarrhal affection of the mucous membrane of the nostrils, due to the victim's especial sensitiveness to the irritating effect of dust from plants and flowers. The name of the ailment is misleading, as the having season, of itself, is not responsible for the malady. Another wrong impression is that hay fever is caused by goldenrod. Some people dodge this yellow autumn flower as if it were a poisonous snake. They are apt to begin sneezing at the mere mention of the name. Science, however, has fully acquitted goldenrod. Investigators agree that no plant spreads hay fever unless its pollen floats in the air and can reach the nostrils in normal breathing. They have demonstrated that goldenrod pollen is dislodged from the flower with difficulty, and that it is not given to traveling on the winds. For similar reasons, honeysuckle, lily of the valley, daisy and chrysanthemum have been absolved from blame. Even the rose, which long was held responsible for "rose fever," now is held guiltless.

HAY fever has some curious kinks. Although pollen dust reaches the noses of almost everybody, many people are not sensitive to the infection. Curiously some sufferers are sensitive to one type of pollen and not to others. Ragweed, for instance, will set one person to sneezing at the first contact, while grass pollen will leave him unharmed. Others react to the pollen of wormwood, but not to that of other grasses or ragweed.

In the cycle of a year the United States passes through four hay fever seasons. Some sections of the country start sneezing in February and keep it up till the end of April. These sufferers are affected by pollen dislodged from trees. Early spring

winds bear dust from the oak, cottonwood, ash, elm, maple and walnut. These woodland specimens cause hay fever in many states.

Late spring finds a new cause of infection in pollen from grasses. Residents of the Eastern states dread the presence of redtop, June grass and timothy. In the Middle West the offenders are June grass and sweet vernal grass. The sneezing season created by these growths extends through April, May, June and July.

Summer brings out the full strength of the docks, goosefoots and amaranths. In some states these plants are the principal cause of hay fever from June to September.

AUTUMN is the time when a large percentage of hay fever victims suffer their attacks. I knew one man who lived for forty years with the certainty that his sneezes would start August 3d—never on the second or fourth day of the month, not always on the third. The fall siege continues till the pollen is killed by frost. This type of hay fever is caused mostly by ragweed, which grows almost everywhere east of Kansas. In the Southwest the amaranths are the worst offenders.

Of all the plants ragweed and timothy are held mostly to blame. The U. S. Public Health Service estimates that close to one tenths of the spring attacks in the Eastern states are caused by timothy, and that a similar proportion of fall attacks may be charged against ragweed. These wind borne pollens often travel as far as five miles.

Detection of the particular pollen or fraction of pollen which affects the individual, is determined by a method involving trial and error, through applications or injections of pollen extracts on the arm of the subject. If, for example, the patient shows a marked reaction to ragweed extracts, the doctor knows that ragweed pollen is the one to which he is most sensitive. If the response is greatest to the proteose fraction of ragweed, the practitioner has further guidance toward adequate treatment.

Such tests accomplish two things. They permit treatment with immunizing injections of the particular pollen in extract form, and they reveal which plant must be shunned by the patient. In the latter respect, often a change of residence will work wonders. To be beneficial however, such a change must be guided by accurate scientific knowledge. I know of a fall victim in Florida who sought escape from his annual attacks. Hearing that the mountains furnished relief, he bought an expensive home near Asheville, in the Blue Ridge of North Carolina.

This apparatus, recently installed in the University of Pennsylvania Hospital, measures reactions of the patient to various pollens and dusts, and so aids in determining causes of hay fever and asthma

This man found himself a victim of half knowledge. Science has demonstrated that mountains are beneficial only if their elevation is too great for the growth of the hay fever weeds. This condition is not likely to exist below 6,000 feet. The North Carolina home of the Florida sufferer was less than 2,000 feet above sea level; instead of finding immunity, he found a region abounding in ragweed with profuse crops of pollen. He was worse off than if he had remained in Florida.

I KNOW of another man—and there are many like him—who never permits himself the luxury of an automobile outing in the fall. He refuses to go even to the suburbs of his own city, because such excursions expose him to weed pollens and set him to sneezing. The same man cannot take a railway journey in the season of distress. The right of way of the average railroad is lined with weeds, and the pollen from these plants whirls into the cars with the vortex of air created by the moving train. The action of the pollen on the nostrils usually is aggravated by dust, smoke and cinders. The combination is likely to produce severe paroxysms of sneezing. Not uncommonly a railway trip of an hour or so will develop an attack of hay fever lasting ten to fifteen hours.

During a railway journey some protection is afforded by breathing through a moistened handkerchief, or by placing aseptic wool within the nostrils. At the end of the trip the nostrils may be cleared by washing them with warm salt solution, in a proportion of a tablespoonful of salt to a pint of water.

There are people who suffer hay fever attacks even when no pollen is near. In some cases the trouble is due to the close proximity of horses and mules. Before the day of the motor car, such sufferers could not travel in vehicles drawn by these animals without being thrown into convulsive sneezing. The provocation in these cases came from the dandruff dislodged from the hair-coats of the animals. Inhaled by the sensitive traveler, the fine dust produced hay fever or asthma, or both.

DURING the World War this source of infection formed a real problem for the United States Army. Numbers of men in the cavalry and artillery developed severe attacks of hay fever from inhaling horse dandruff. The trouble was overcome by the simple expedient of transferring the sensitive soldiers to the infantry.

I have heard of one man who cannot sleep on a feather pillow. The dust from the feathers brings on an attack of hay fever. His sole recourse is to use pillows stuffed with cotton or moss. One of his friends cannot sleep under a woolen blanket, nor stay in a room in which there are woolen rugs, because the wool dust produces intense distress. The Public Health Service has found that many people are affected by feathers and wool.

In one puzzling (continued on page 154)

The three scientists whose chemical analyses of pollen have led to the recent discovery of a valuable new treatment of hay fever. From left to right they are: Frank A. Gooding, of the U. S. Bureau of Chemistry, Dr. Harry S. Benton of Georgetown University, and D. Breese Jones

The Antville jazz band in action. A scene from the remarkable new movie romance of the ant world, "Youthful Ecstasy"

At the roadside inn our hero, Mr. Insect, joins in dancing and revelry far into the night. These lifelike movie figures are constructed of wax, plaster and lead

Strange Ants Grow Flowers

Insect Colonies Also Found That Bake Bread and Gather Gold

By HYATT E. GIBSON

ANTS that bake bread, plant aerial gardens, and roll up by the hundreds of thousands in huge floating hosts are now described by a German biologist. Dr. Hans Heinz Ewers, whose amazing observations in all parts of the world seem to endow these diminutive insects with almost human intelligence.

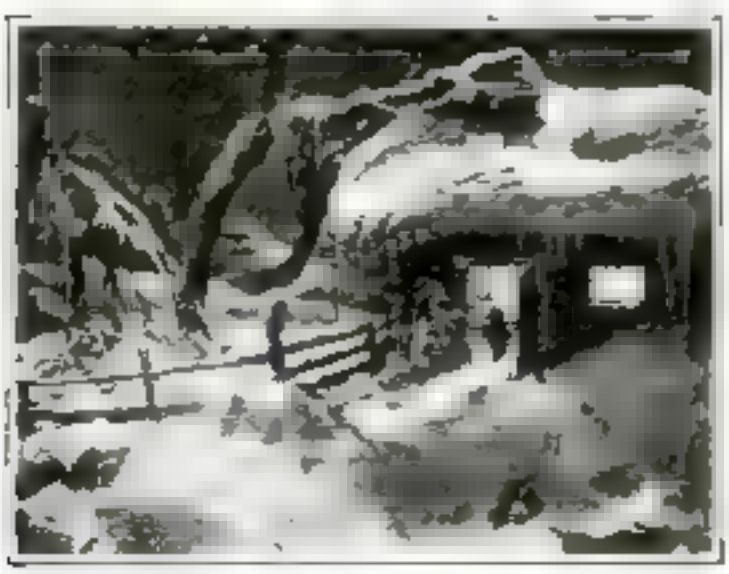
From some waspike insect ancestor, says Dr. Ewers, probably came all the different species of ants—between five and six thousand known to man. Engineers and carpenters, farmers and warriors are among them. Indeed, so humanlike are these little insects in their daily round of living that a remarkable motion picture drama recently has been produced, with ant figures as the actors throughout. A few of the scenes from this production, conceived by a Russian inventor, W. Starewitsch, and created by Ufa Films, Inc., are reproduced on this page. While the figures of the ant actors are made of wax, plaster and lead, their actions as depicted on the screen are hardly more amazing than are the actual incidents that occur in colonies of living ants in many parts of the world.

Mr. Insect and his convivial party raise their glasses in a toast to the ant girl dancing on top of a mushroom table

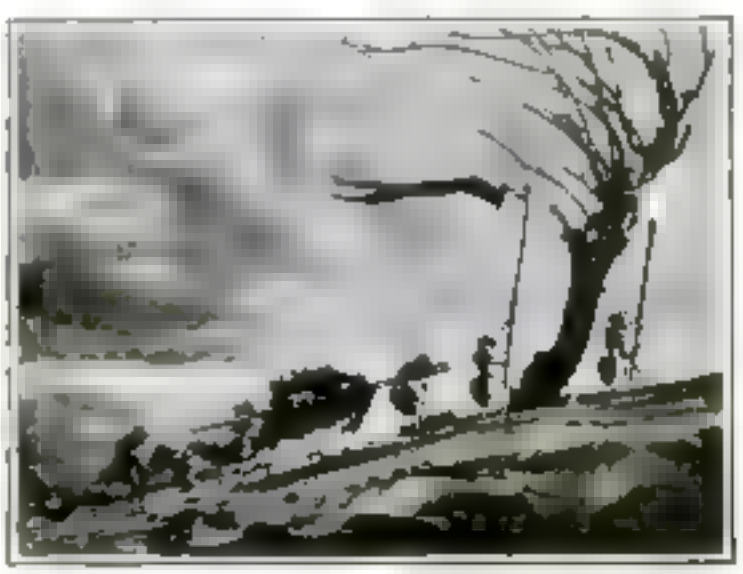
For example, though torrential rains may drench the tropical forests of America where the humpbacked ants live, their nests of molded earth in the treetops are secure against the flood. Each of these nests is a hanging flower garden, and the plant roots hold it together. Observation has shown, says Dr. Ewers, that the ants deliberately plant their gardens with seeds. Some of the plants in these gardens are found nowhere else in Nature. And each individual species of Humpbacked ant cultivates a different kind of flower in its airy garden, a fact that makes it difficult to believe the planting of the seeds was accidental.

Powerful tribes of ants such as the tropic Amazons make slaves of weaker races, who feed them and care for their young. In some nests discovered, the slaves outnumbered the Amazons fifteen to one! Warfare and primping occupy the time of the Amazon masters, who in the midst of a slave-hunting expedition will stop to insert a glistening polish to their horny bodies. In an attack on an alien "ant city," the Amazon warrior with its deadly jaws is a ferocious combatant. Curiously enough, the timid slaves themselves grow bold while living under Amazon rule. Apparently the slave takes on the character of his master.

Queerest of all perhaps, is the self sacrificing Honey ant. Most ants feed each other mouth to mouth from their crops, but certain of the Honey ant workers have *(Continued on page 144)*

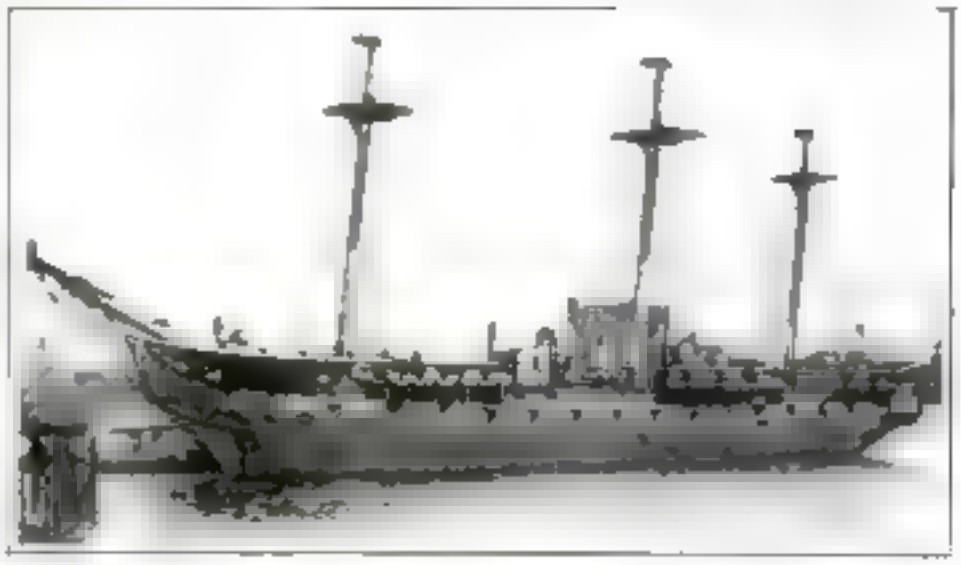


At last Mr. Insect quits the party and reels homeward —to be met at the door of his cottage by an irate wife



The final act of the drama—a funeral procession bears the remains of Mr. Insect to a lonely hillside grave

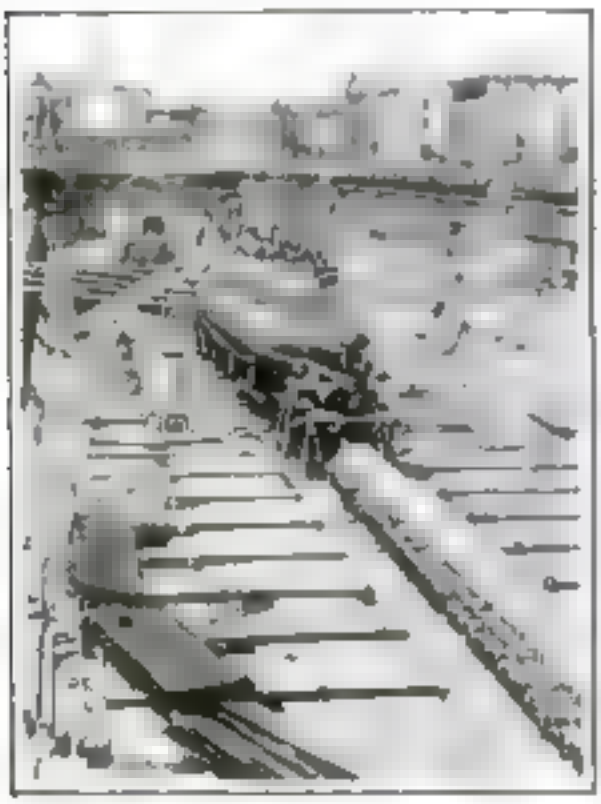
Some of Uncle Sam's fighting ships participating in the recent naval war game off the New England coast as seen from the U.S.S. *Idaho*. The "Black" fleet representing the invaders, was repulsed by the defenders. Note the small planes perched on the deck



Our many readers who have built the Popular Science Monthly model of the U.S.S. *Constitution* will be especially interested in this photo of Old Ironsides" being towed from her pier at Charlestown, Mass. where she has been tied for 30 years

Great-Grandchildren of "Old Ironsides"

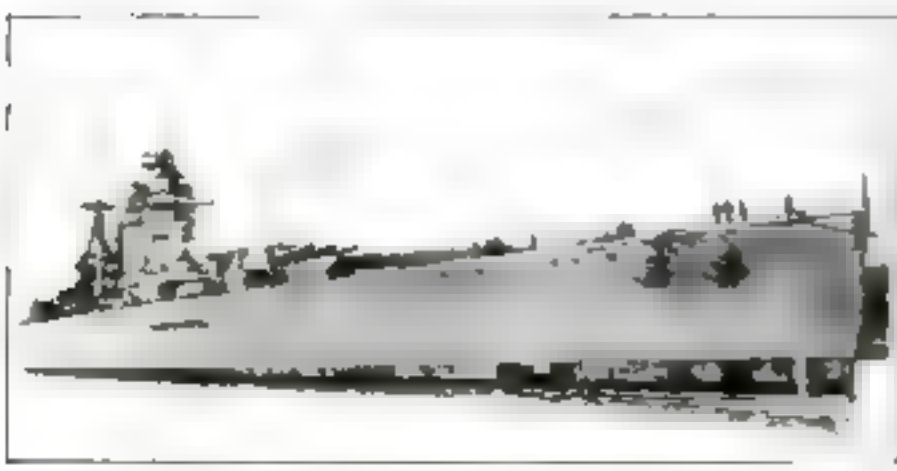
Famous Frigate Lives to See Mighty Armored Machines Rule the Sea



Like a fly in a sugar bowl, the little U. S. submarine *S 11* is almost lost in the huge Navy drydock at Charlestown, where she went recently for repairs after returning from naval maneuvers in the Caribbean Sea. Compare this picture with the one on the opposite side of the page. They give an idea of the vast cradles where any fighting ship, from the smallest diver to the largest battleship, can be hauled from the sea

The *Colorado* shoots into the Brooklyn Navy Yard drydock after being hauled from Diamond Reef in New York harbor

It looks as if the destroyer at the left were in distress. Actually though, she is sitting in her own drydock. When the ship's hull needed scraping and repainting, an ingenious commander conceived the method of shifting ballast causing the vessel to list sharply. "Gobs" in boats speedily cleaned the bottom



Revolutionary design has given the title "mystery ship" to Great Britain's new $25,000,000 battleship *Nelson*. Bombproof decks are said to make her invulnerable to air attacks, while her underwater armor is heavy enough to resist the explosions of four torpedoes

The U. S. S. Colorado hard aground on Diamond Reef in New York harbor during the recent visit of the U. S. battle fleet. For many hours tugs and mine sweepers labored vainly before at last they succeeded in freeing the $26,000,000 warship. Two bottom plates were ripped off and two blades of the port propeller were split

Model Making a Growing Fad

Midget locomotives that really run; a battle carved from wood; other unusual miniature examples of fine workmanship

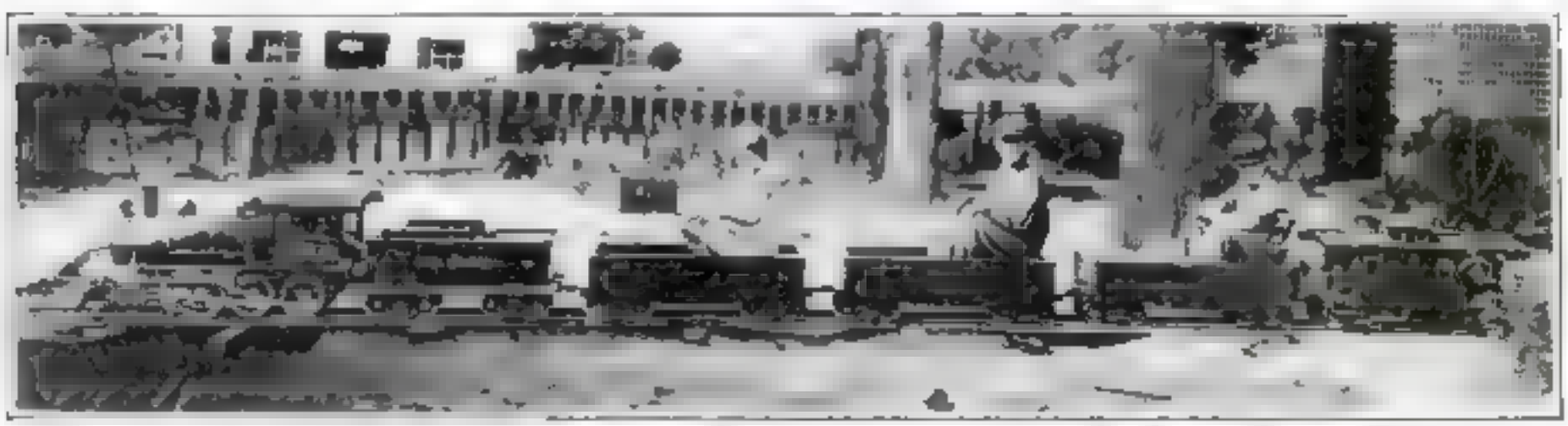
Photograph shows a French artist [illegible]

J. M. W[illegible] Los Angeles Calif. who [illegible]

One of the [illegible]

Five hundred [illegible]

The [illegible]



The miniature locomotive that pulls this back yard railway train runs under steam from its own boiler. Constructed by William L. Dewey, of Pueblo, Colo., the locomotive is a counterpart of those on the Cuba Northern Railway. Dewey also made the train of cars to go with it

Plane Hauls *a* Glider *in* Aerial Train

The tug plane is the first of its kind in history. Left: The glider pilot releases the tow rope and glides down to a safe landing

FUTURE "air trains," with powerful airplanes for locomotives and motorless gliders as cars, have been predicted as a result of an amazing experiment recently performed at the Karlsruhe flying harbor, near Berlin, Germany. In the test a Raab-Katzenstein biplane took the air towing a full sized glider—probably the first attempt of its kind in history. While in full flight at an altitude of 100 feet, reports state, the glider's pilot cut his machine loose and swooped down to a safe landing, the towing plane landing near by.

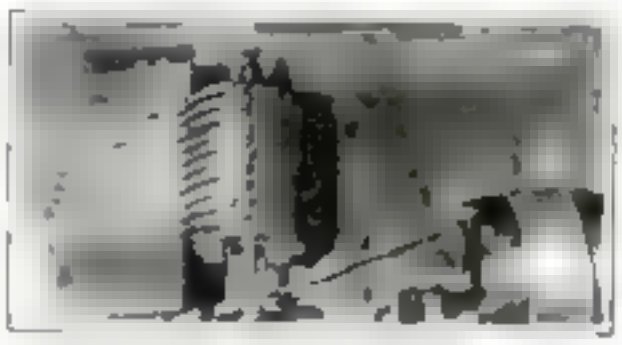
"In my view," said the German pilot Espenlaub, who built and maneuvered the glider, "long distances can be covered without difficulty by a plane and a glider in this fashion." Other observers are even more optimistic of gliders carrying passengers and freight bound for several points along the line of flight. As the towing plane passed over an important town one of the gliders would be released from the end of the train and descend with its own special pilot and its passengers. The rest of the train then would continue its flight.

How this might be done was demonstrated in the Karlsruhe experiment. An automatic release enabled the glider's pilot to disconnect his machine at will from the large plane by loosing the thousand foot wire towrope.

"Radio Watchman" Guards Ohio Reservoir

A RADIO station plays watchman in keeping guard over the water supply of Akron, Ohio. Every hour it transmits the water level in the city reservoir, so that operators in the pumping station fourteen miles distant may know how to regulate the water flow.

The sending of the report is entirely automatic. At five minutes before the hour a master clock, set twice a week by radio time signals, turns on the transmitting set. Relays go into action and start an electric motor that rotates eleven hard rubber disks. On each disk edge is a series of ridges and notches, arranged in the form of a wireless telegraphic code. Each of the eleven disks announces a certain water level. Brass arms, resting on the irregular rims, move up and down to make and break the circuit like ordinary telegraph keys.

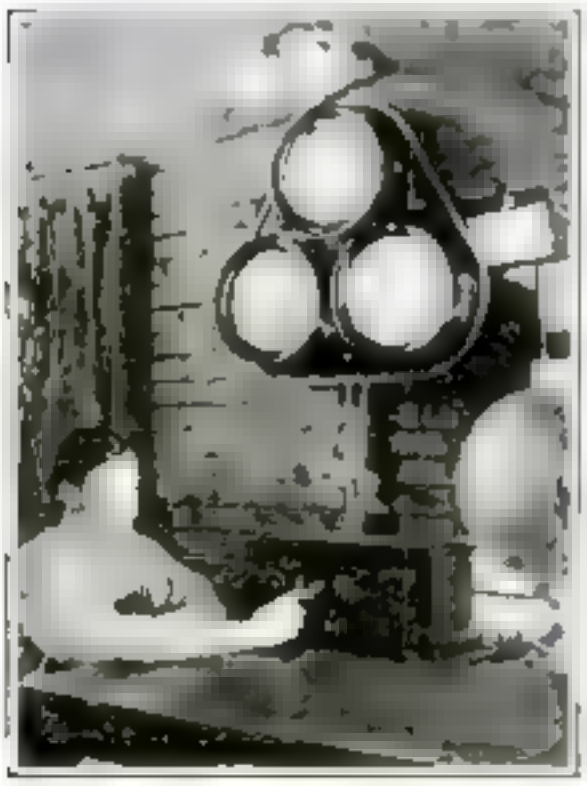


Rotating disks, with notched edges that control electric contacts, send the signals

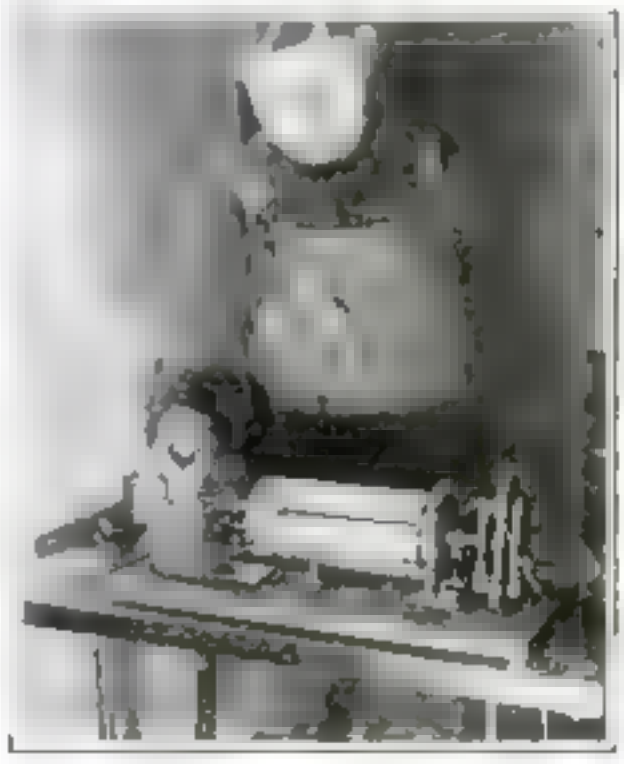
The result would be a jumble of eleven messages, were it not for the water level indicator—a device resembling an automobile timer, that energizes but one of the disks at a time. Which one becomes "live" is determined by the position of an electric switch arm within the timer, controlled by a water level float through a steel tape. Thus the water broadcasts its own water level.

At the pumping station the signals are picked up by a standard three-tube receiver. From its loudspeaker they can be heard in any part of the works.

Before the radio installation was made, the reservoir attendant reported the water level by telephone several times a day. Whenever telephone service broke down, he was forced to drive the fourteen miles to the pumping station.



William Manfrass, inventor of the system, with the clock-controlled radio receiver



Converted by a water level float, this switch apparatus controls the transmission disks

Even Worms Solve Puzzles

Ingenious Mazes and Problem Boxes Test Wits of Rats, Birds and Cockroaches in Amazing Experiments

By PRESCOTT LECKY

DID you ever hear the story of the dog with a stick in his mouth trying to get through the hole in the fence? According to this legend, the dog dropped the stick, picked it up again by the end, and went through the hole.

In the old days we smiled with admiration. Nowadays, still smiling, we ask, "Where is this dog?" Any animal psychologist will be glad to provide a suitable one and stick, if you will promise the canine genius, and if the act comes off as advertised he will cheerfully believe your story. Otherwise—not!

Animal psychology had to outgrow the anecdote and devote itself to experiment before it could progress. Like the older sciences, it has set up its laboratories, developed its special apparatus, and perfected its technique of measurement. A young science, born in the present century, it has already discovered more remarkable facts about the behavior of the lower animals than the field naturalist ever dreamed of. For in laboratory work scientists do not wait till something happens and then try to interpret it. They arrange the situation and help things to happen!

FOR example, Prof. Norman Triplett of the Kansas State Normal School was wondering not long ago whether a fish, an animal well down toward the bottom of the evolutionary scale, could learn to control its natural desire to dine upon small minnows. He knew that he would never observe any such restraint in Nature, even though he sat on the bank of a mill pond the rest of his life, so he tried an experiment.

Two perch were placed in a glass tank and permitted to feed on minnows for several months. Then a glass partition was slipped in, dividing the tank in two. On one side, perch; on the other, minnows. Glass between. Smack! As the perch rushed forward they collided with the barrier full force. Undaunted, they returned to the attack and butted their heads again. This continued without interruption for seven minutes. The perch gave up for a moment, then tried again with gradually waning energy. Till at the end of thirty minutes the minnows were removed.

THE experiment was repeated every day for a month. In the meantime the fish were fed with angleworms. Gradually they lessened their attacks and at last gave up altogether their attempts to reach the minnows.

It was then that Professor Triplett gave them a real test. He removed the partition and the perch, no longer interested in the minnows, remained peacefully on their own side, while the minnows crossed over and joined them, and both large and small fish swam about together, neither kind paying any especial attention to the other!

They remained together in peace for several days. Occasionally a perch approached a minnow and followed a little way, but at the last minute he turned and swam off. It was evident then that even a fish can learn to control himself!

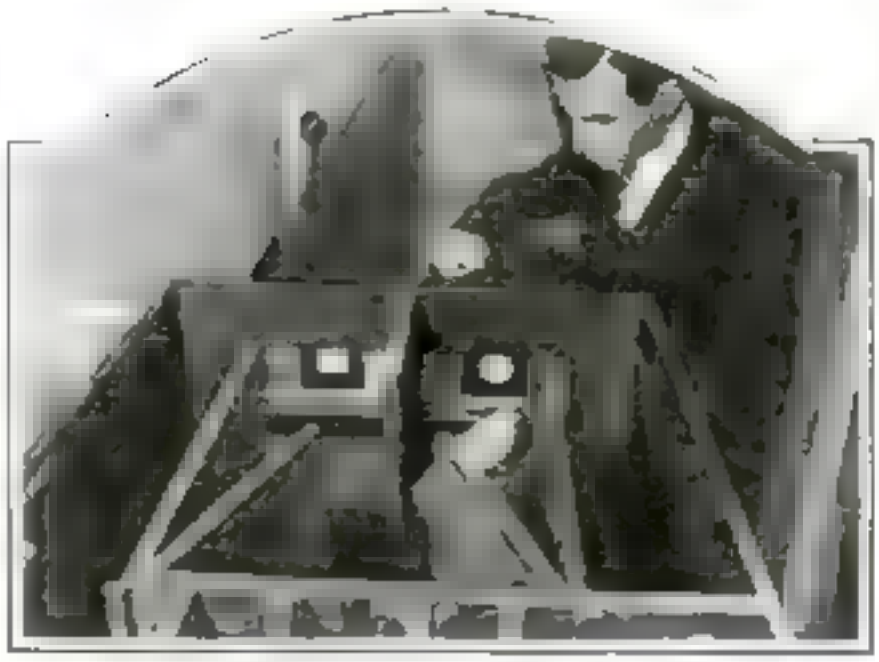
Just prior to this experiment a famous European biologist had asserted that fish could learn nothing. Now, though, it is known that all animals, even the one-celled variety, can alter their behavior to some extent, even though the change may not last permanently. Dr. Asa A. Schaeffer, of the University of Tennessee, has shown that the frog, another cold-blooded animal, is able to learn a similar lesson in a single trial.

THIS frog was fed on worms and bugs. Included among the latter were cockroaches, which the frog regards as a dainty tidbit. Then an electric battery was connected with the damp sand on which the frog was seated, and a fine copper wire, also connected with the battery, was wound about a cockroach. The frog snapped up the bug, received a moderate shock, and hastily spat the insect out again. This one experience proved to be sufficient. For nine days the frog refused to eat at all, and then would take only worms. He had lost his appetite for cockroaches completely, for the time being, at any rate.

How long the altered habits would last is a question, but probably not very long. As we pass up the scale of life we find that the higher organisms not only learn more complex tasks, but they retain the habits for a longer time. That is why laboratory training and testing of animals is so valuable; it gives us a key to their intelligence. In the near future the animal psychologist probably will have evidence, for instance, as to whether a dog is more intelligent than a monkey, or a monkey than a young human baby. Perhaps, before many years, he will have tests which can be applied to pedigreed dogs, to entries in horse shows, and so on, to the end that blue ribbons may be awarded for animal brains as well as beauty.

NOTHING in the behavior of an animal is more remarkable than its ability to find the shortest way to its home or to food. To study this characteristic, the apparatus commonly used is the maze, a closed labyrinth ranging in difficulty from the simple choice of right or left to highly complex patterns. One of the most intricate is the Hampton Court maze, patterned after a famous parkway in England. The hungry animal is admitted to the maze in an outer alley and must

find its way to the food in a large square in the center. Almost any animal, of course, could find the food eventually if he tried hard enough. The real task is to learn to take the shortest route, to follow consistently the correct pathway without turning off into numerous blind alleys along the way. You will find it none too easy to follow the right path even in the photograph, at the bottom of page 33, and remember that the animal cannot see the whole problem as you can, but is down between the walls with nothing but more walls in sight!



Ingenious apparatus used to determine whether birds can distinguish between different forms of about equal area. Here the bird, having chosen the circle correctly is being rewarded with food. Had it chosen the square it would have received a mild electric shock. The apparatus is used also for studying color vision and optical illusions

AS A matter of fact the animal will make many errors and waste much time on its first attempts, but gradually after repeated attempts these errors are eliminated. Its final performance is amazing. Often a rat will start out as fast as it can run and thread the entire pathway without a mistake. There is no hesitation whatever. It runs by the open blind alleys as if they did not exist. Even several months later, without intervening practice, the rat can repeat the performance almost perfectly. Like our own motor habits of skating, swimming, dancing, typing, and so on, the habit seems to stick.

Just why the rat ever learns to select the shortest possible route is still more or less a mystery. Psychologists are still battling over various theories. One point, however, seems fairly clear—that *he learns by doing*. If he is put in a basket and carried through the maze, he learns nothing; but if he is pushed through he learns rapidly, a fact which was demonstrated by Prof. H. A. Carr and Prof. John B. Watson, of the University of Chicago, not long ago. Apparently he learns with his legs, for not only does he run as well in the darkness as in daylight, but if a barrier is put in his way, or the distance between turns is changed, he will dash straight into the obstruction or the walls of the maze.

Elaborate electrical "obstruction apparatus" developed in the laboratory to measure the driving force of animal instincts, such as hunger, sex and fatigue. In each case the obstruction to be surmounted by the instinctive drive is a mild electric shock

THE Hampton Court maze is used in experiments with rats and mice in the animal laboratory at Columbia University, New York City. Some mice form the habit reasonably well in twenty-five or thirty trials, but the average is about seventy. Rats, for some reason, learn with fewer trials. For birds this maze is much more difficult, and even monkeys do not do especially well, though for the latter it is hardly a fair test. Running about in long closed passageways is not a natural activity for them. Guinea pigs and porcupines also require a simpler pattern.

The latest development in this field is the Warner-Warden maze designed by Dr. Carl J. Warden of Columbia and Dr. Lucien Warner,

An adjustable metal maze developed by Dr. Carl J. Warden of Columbia University (right) and Dr. Lucien Warner of New York University. It can be taken apart and rearranged in any pattern desired. The trained rat which Dr. Warden is introducing into the labyrinth at the right will reach the food box in about four seconds

of New York University. This apparatus is built up of identical metal units, which can be arranged into any pattern desired. Research is now in progress at Columbia to determine the relative difficulty of a maze of eight blind alleys, as shown in the illustration at the bottom of this page, and one with six, four, or two blind alleys. A study of the photograph will show that all the angles in this maze are exactly the same, which makes it possible to formulate standard tests of graded difficulty for animals just as standardized intelligence tests are used in schools. A maze of the same type, but large enough for dogs, cats, raccoons and monkeys, also will be built, and possibly a small one for worms and insects.

Perhaps you imagine that worms cannot learn. But a common earthworm actually has been trained by Professor Robert M. Yerkes at Harvard University to take the path to the right by the simple method of penalizing left turns by giving a mild electric shock. Crabs, snails, crayfish, turtles, and fishes all can learn mazes with one or two blind alleys, and the cockroach easily learns a maze of three or four.

A COCKROACH maze was designed by Professor Szymanski of Vienna as a pathway without sides supported over a basin of water. The insect that did not follow the pathway was penalized by a ducking.

A maze was once built at Chicago large enough for human subjects. It was found that blindfolded children and college students required about as many trials as rats had taken on a maze of similar shape.

In Germany a few years ago several horses trained by a Mr. von Osten were said to be able to solve arithmetical problems. Apparently they could add, subtract, divide, multiply, extract square roots and cube roots, read and spell. They could even do problems involving fractions.

One of these horses, known as "Clever Hans," was studied carefully by a scientific commission. No trickery was discovered — the horse solved many problems correctly even when the trainer was absent. But this only increased the mystery and a second commission was formed. This time a curious discovery was made. Unless some person in the room knew the answer to the problem, Hans could not solve it! To all appearances, a telepathic horse!

Two more steps and the mystery was solved. When a blind was put on the horse's eyes, he could not solve the problems even though everyone present knew

Continued on page 148

Modern Hospital Sails with U. S. Fleet

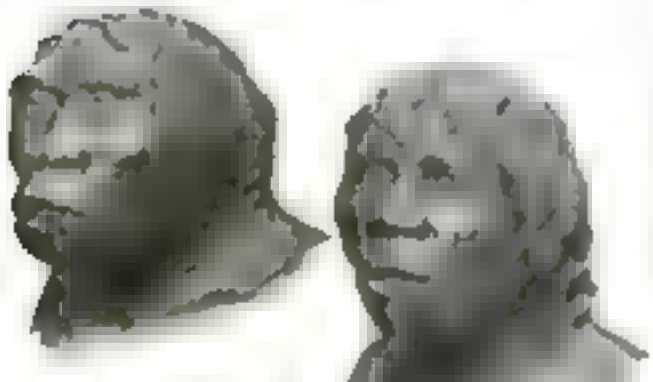
The U. S. S. *Relief* only

WHEN "gobs" are ill the Navy has a marine hospital ready for them. The U. S. S. *Relief*, only all-hospital ship afloat, ons accommodations for 540 patients. A trip to the *Relief* now replaces a lengthy voyage to a land institution and the vessel is said to be better equipped than many hospitals. Its staff of physicians may draw upon the ship's dispensary for all medical supplies. Enough stock is carried to last six months, when the ship accompanies the fleet on a cruise.

For injured sailors, there [illegible] operating room. Interna[illegible] are performed in a modern X-ray room. Other separate clinics care for [illegible] treatments. The Navy's [illegible] in the dental cabin. Modern [illegible] includes all-metal stretchers of [illegible] form, to bring injured [illegible]

Six hospital wards afford [illegible] for

Man Was Never an Ape—*Henry Fairfield Osborn*



Above: So-called Java "ape-man," of 500,000 years ago. Right: Prehistoric Piltdown man, who lived in England

YOUR ancestors were neither apes nor human beings, says Prof. Henry Fairfield Osborn, president of the American Museum of Natural History in New York City and one of the world's foremost paleontologists. In an address before the American Philosophical Society in Philadelphia a few weeks ago, Professor Osborn expressed the belief that the forerunners of modern men were "dawn men" who developed independently of the apes from some prehistoric animal not yet discovered.

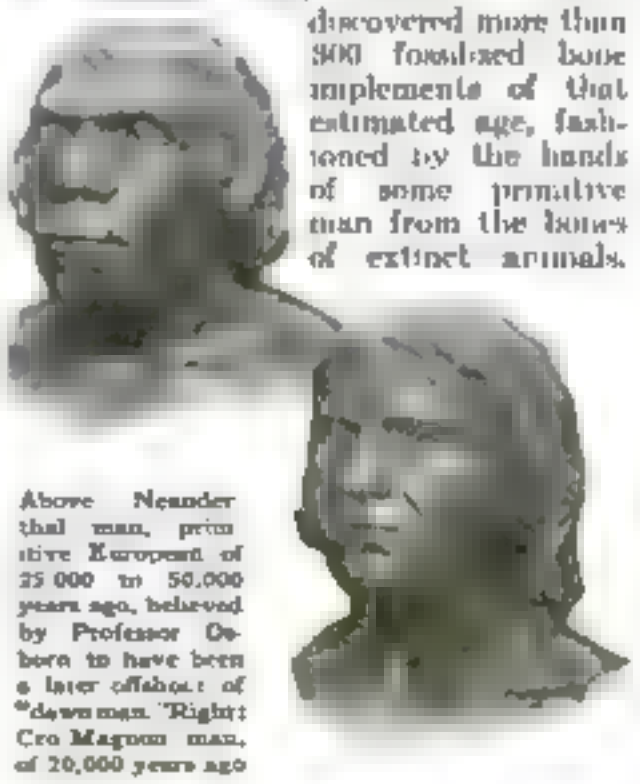
There is promise of an interesting scientific controversy in the fact that disagreement with Professor Osborn's theory was expressed on the same occasion by Dr. William K. Gregory, former pupil of Professor Osborn and an expert also associated with the American Museum. According to Doctor Gregory the close similarity between the bodies and minds of modern apes and men is strong evidence that the direct ancestor of both was an ape. This, he recalls, was the original idea of Darwin, to which he urges that scientific theory must return.

In recent years the most commonly accepted theory has been that men and apes both were descended from a common apelike ancestor.

In support of his "dawn men" Professor Osborn puts man's origin, not thousands of years ago, but sixteen million! Both men and apes first appeared then, he says, therefore man could not have descended from ape ancestry. Traces of man's mysterious ancestor, he suggests, might reward a diligent search in Central Asia, where he believes the "dawn men" first sprang into being.

This "dawn man," the founder of the Mongolian, Negro and Caucasian races, is described by Professor Osborn as ground-living, alert, capable of tool making, and living in the fairly open country of the high plateaus and plains of Asia. The celebrated Neanderthal man, a primitive race of Europe, Professor Osborn believes to be a later offshoot that eventually died out, leaving no descendants. "Pithecanthropus erectus," of Java, usually considered the earliest of our ancestors, may be one of the last of these Neanderthals, he adds, and therefore no direct kin of ours. New geological discoveries have shown much earlier the Piltdown men of England, perhaps the last of the "dawn men."

Prof. Osborn's belief in "dawn men" and their more mysterious ancestry is supported by a recent discovery that apparently shows men existed at least four million years ago, long before previous estimates of man's antiquity. In a Nebraska hill, Professor Osborn discovered more than 300 fossilized bone implements of that estimated age, fashioned by the hands of some primitive man from the bones of extinct animals.



Above: Neanderthal man, primitive European of 25,000 to 50,000 years ago, believed by Professor Osborn to have been a later offshoot of "dawn man." Right: Cro Magnon man, of 20,000 years ago

Latest Rewards *of* Research

On these pages are presented each month brief stories of notable scientific discovery and of achievements in research and invention that have a practical bearing on our everyday problems.

Telephones from the Ocean Bed

WILLIAM BEEBE, famous naturalist-explorer, scores another remarkable feat in undersea adventure. Returning from a trip over and under the waters about the coral reefs of Haiti, he brings with him descriptive records of strange creatures never seen before—records dictated by him over the telephone while walking along the bottom of the sea!

"There are so many interesting things down below," he explains, "that you can't hope to remember them all when you come to the surface." For that reason he installed in his diving helmet special telephone apparatus, by which he was able to dictate his observations to an assistant aboard his four masted schooner anchored above.

One of the strangest discoveries he recorded in this way was a transparent fish that carried swarms of smaller fishes, like passengers, in its stomach! Whenever the little fellows wished a free meal or a free ride, they would swim right through the mouth of the transparent fish into its spacious dining room. Sometimes there were as many as 300 of these passengers, all alive and happy.

The wonders of the sea apparently are as limitless as are the marvels of electrical communication.

On the site of the first Indian salt mine discovered in North America, recently found in Nevada, M. R. Harrington of the Museum of the American Indian, New York City, staged this re-creation of an ancient mining scene. Two full-blooded Indians, using primitive stone tools, are seen hacking at the salt ledges

Treasure from the Dead Sea

THE Dead Sea soon may come to life. Deepest and neglected for centuries, this lowest and saltiest large lake on earth may aid in taking the knock out of automobiles, in fertilizing farms, in supplying the world with medicines, and in making cements. For chemists recently have undertaken to extract and separate the valuable salts which the Dead Sea is known to hold. Its waters, they say in their report, contain nearly twenty-five percent of salty matter, consisting largely of two valuable chemical elements, bromine and potassium. Some two million tons of bromine, and an almost equal amount of potassium, are lying there waiting for the world to get around to the use of it.

Bromine, a heavy, dark red liquid, is used in making gasoline for airplanes. Potassium is the essential element of potash, used for fertilizers. In addition, the Dead Sea contains millions of tons of compounds of magnesium, which is used for medicine and in the manufacture of cement; also many cubic miles of common salt.

London capitalists are reported to be backing the project of chemistry to raise the salt sea from the dead.

Oil Ships and Rainfall

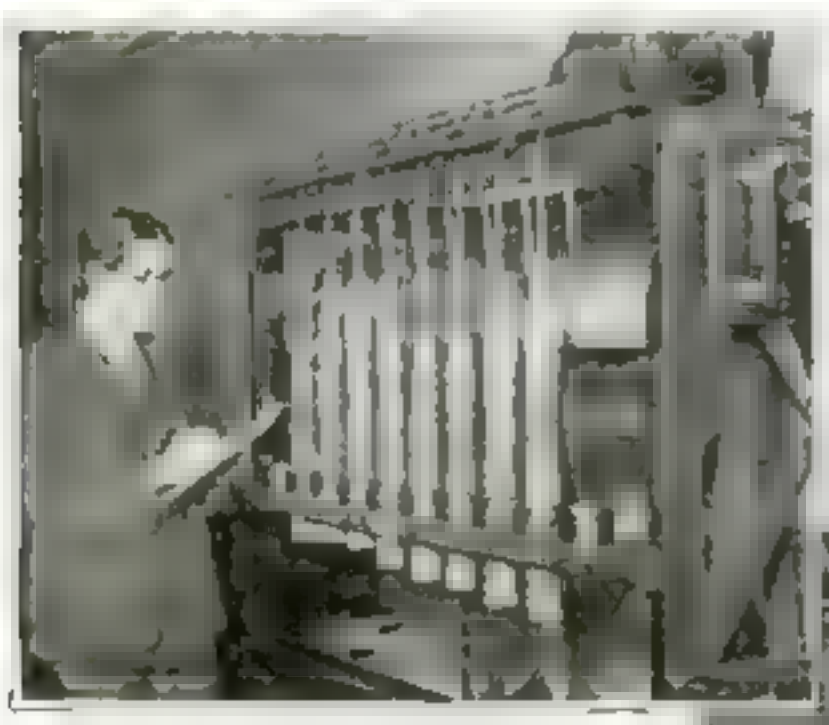
STUDIES of weather records indicate that the world's average rainfall has decreased about one percent in the last half century. Heretofore most experts have believed that this has been due to forces outside the earth, such as variations in sunlight, and that the decrease will be made up by a corresponding increase later.

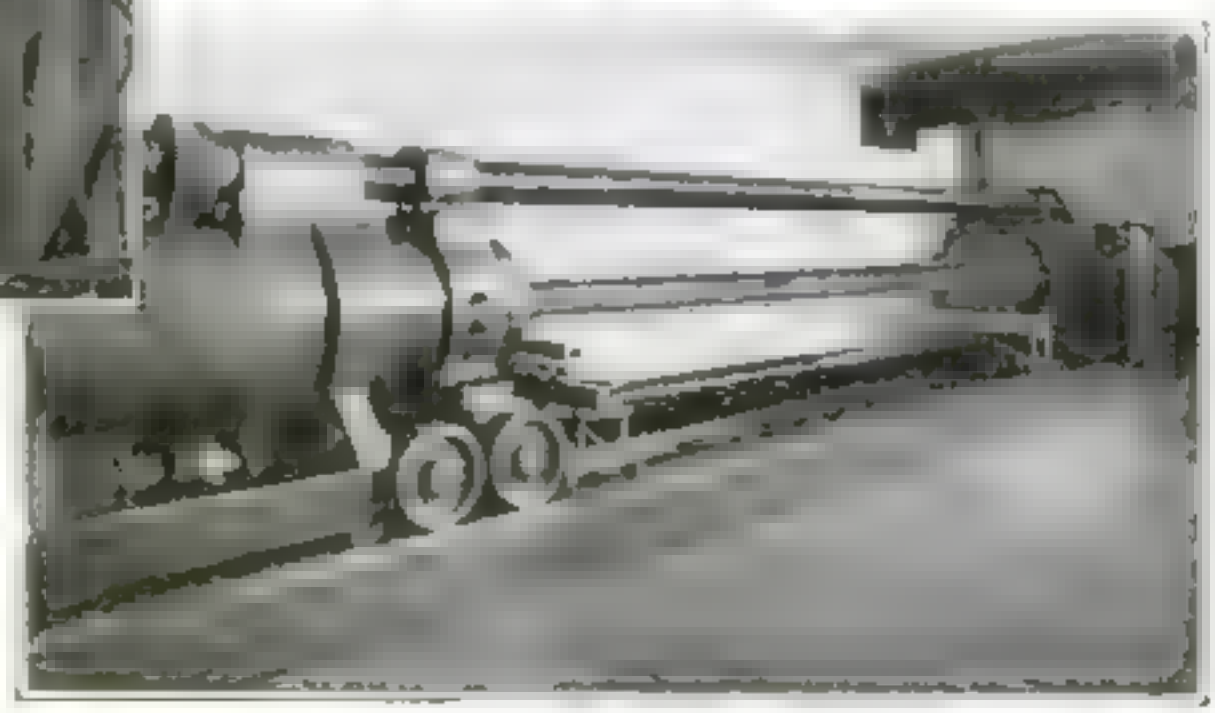
But now an Indian weather expert, L. A. Ramdas of Karachi, comes forward with the surprisingly plausible suggestion that the lack of rain is caused by oil film spread on the surface of the oceans by ships that burn oil for fuel. This film, less than a millionth of an inch thick, he says, may be sufficient to retard the evaporation of ocean water, which is the chief source of rain!

No doubt many mysteries of world weather, its changes, causes and effects, will be solved soon, for thirty nations recently joined in international cooperation to make weather records of all countries more easily available for study. From reports of ships at sea, special efforts will be made to gain new knowledge of the meteorology of the ocean, which greatly influences the weather of the land.

Metered Fuel for Homes

IN NEW YORK CITY a recent survey shows, more than seven billion pounds of steam, piped from central heating plants, were sold by meter last year to owners of skyscrapers and apartment houses. More than two thousand buildings are now equipped, the largest in Manhattan being an average of three and





Two of the engineering marvels of the U. S. Bureau of Standards, where almost every article in common use is subjected to severe tests. Here are shown how steel girders are tested for strength and rigidity. In the photograph at the right, pulling or pressing with a force of a million pounds measures the ability of steel girders to bear tons of weight in skyscrapers or bridges. The girder in the photograph is bending under terrific pressure

Records of Strange Fishes Telephoned from the Deep; New Lightning Camera; Useful Discoveries of the Month

one half million pounds of steam each and used it for heating power, refrigeration and cooking. Forty miles of steam mains have been laid in the east side of the city.

Meanwhile, on the opposite side of the continent, two wells driven in a field of hot springs in Sonoma County, Calif., have been yielding nearly 5000 horsepower of live steam. According to Dr. Arthur L. Day of the Carnegie Institution of Washington, further commercial development of these steam wells offers fascinating possibilities of running engines and dynamos without burning a pound of fuel.

Evidently the time is approaching when we'll buy steam instead of coal in much the same way we now buy electricity or gas. No longer will we worry about the winter fuel supply, or carrying out the ashes, for the household fire-box will be a thing of the past.

Freakish currents that lightning causes in electric wires lasting a millionth of a second or less, are photographed by this new camera developed in the General Electric Company laboratories, Schenectady, N. Y. It is used to study the efficiency of lightning arresters

Eyeglasses and Efficiency

EVEN if your eyes are perfect, eyeglasses are likely to increase your efficiency, particularly if your work demands close attention. Such, at least, is the conclusion drawn from recent tests by the Industrial Fatigue Research Board in England. In experiments with workers engaged in the exacting task of making women's hosiery, it was found that glasses especially designed for the fine work not only made them less tired at the end of the day but led to the production of more and better stockings.

Models for Flood Prevention

EXPERIMENTS in tow tanks and ponds of models in a long laboratory task were largely responsible for developing the designs of modern naval and merchant vessels. Experiments with airplane models in wind tunnels have done much to promote safe and efficient flight.

Why not, suggests John R. Freeman of Providence, R. I., use laboratory models of cities to solve the problem of the Mississippi floods? Mr. Freeman, former president of the American Society of Civil Engineers, was expert adviser to President Roosevelt on his official inspection of the Panama Canal.

The Federal Government and the states have spent hundreds of millions of dollars in trying to solve the Mississippi's problems," he says. "A week's work with a model at a total cost of a few hundred dollars may tell more than six months' effort and $10,000 spent on an experimental dike in the field. Improvements in the art of training rivers to maintain navigable channels and in making them carry their floods to the sea more safely and quickly, may come from the laboratory."

Can Rays Produce Life?

STILL more wonders follow in the path of ultra-violet rays. Two experimenters in biology at the University of Chicago, Dr. Ralph Lillie and Dr. M. A. Hunter, recently reported they had succeeded in inducing living creatures from unfertilized eggs by means of the powerful, curative rays. Eggs of the sea urchin, placed under the influence of the rays for from five to ten minutes, according to reports, became swimming fish larvae, fathered by none other than a laboratory machine!

In the Academy at Rome, a few weeks ago, Professor Quirino Majorana, famous wireless expert, announced the invention of wireless transmission of speech by means of the same rays. His new method, he declared, has the advantage of assuring secrecy of conversation, and thus would be especially useful for the transmission of Army and Navy orders in time of war.

New Disease from the West

PHYSICIANS have discovered a new American disease called "tularaemia" described recently by the U. S. Public Health Service. Originating with squirrels and rabbits in the West, it has spread to man. It has invaded all but nine states, the New England group, New York, New Jersey and Delaware.

The original coil and glass used by Michael Faraday, celebrated English physicist, in experiments that led to radio and other electrical marvels, have just reached America, the gift of the Royal Institute at London to the Franklin Institute in Philadelphia. Dr. Howard McClenahan, secretary of the Franklin Institute, is shown displaying the instruments

Experts of the Los Angeles Museum of History, Science and Art have undertaken the unique task of "rebuilding" and mounting a huge finback whale recently caught off the coast at Trinidad, Calif. In the photograph at the left Robert Paine, museum sculptor, is seen examining the immense upper jaw. On benches in the background are other bones of various shapes and sizes that will be fitted together

New Thrillers *Defy* Gravity

How amusement park engineers tax their ingenuity to lure us with "flying leaps" and "breathless dips"

By ELWELL CRISSEY

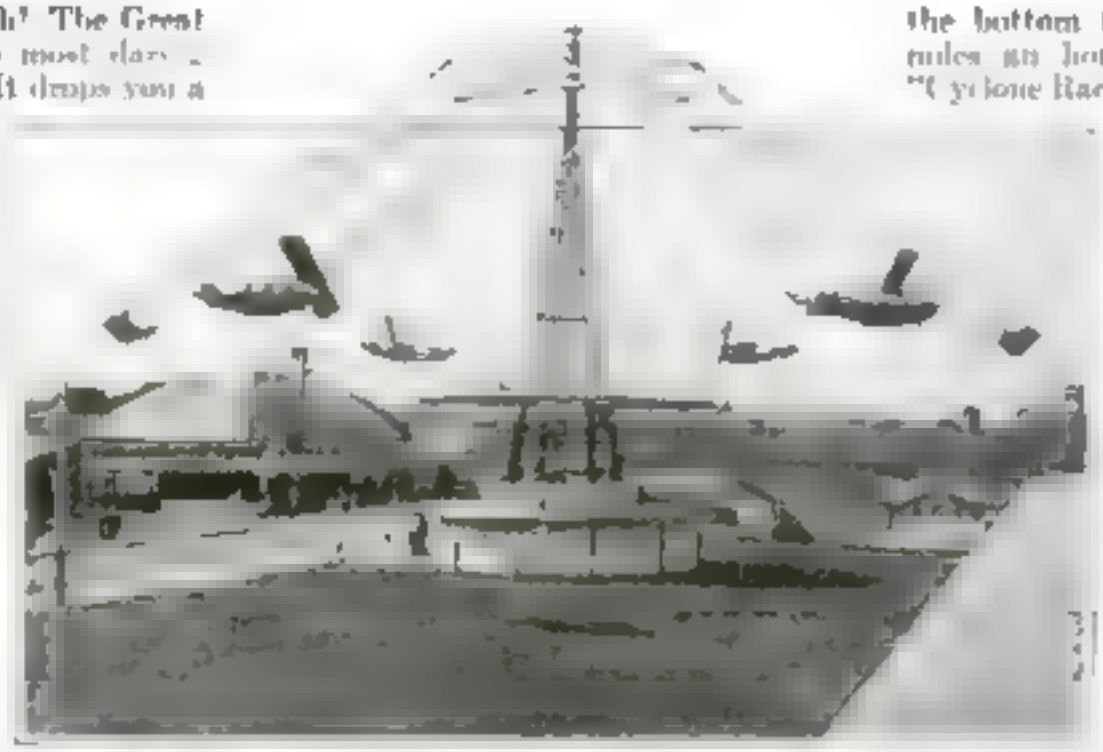
"ALOOKAH! Alookah! The Great Dizzy Dip, the most dare-devil ride on earth! It drops you a hundred feet at a hundred miles an hour! Here you are, folks—the biggest thrill in the world!"

Jostling through the roar of wheels, the hoarse entreaties of hall-lyhoo'ing barkers from passengers, blares of music from carrousel organs and bands, and the scene is typical of hundreds of amusement parks throughout America on a summer night.

The inception, construction and operation of amusement devices, designed to appease the human craving for thrills, has become an important industry in which any successful device involves not only a thorough understanding of crowd psychology but engineering and inventive skill of high order.

Sensation is the chief goal of the inventor of amusement park apparatus. A device which imparts a high power thrill is patronized repeatedly, while one which only amuses is forsaken once the novelty is discovered. Thus the "rides" as roller coasters and similar devices are known, remain the most popular features.

Forty-three years ago, L. A. Thompson, a pioneer in the field, built the first scenic railway at Coney Island, N. Y. It operated small, motorized cars, by means of a third rail, over a loop system, which the inventor called the "Switch Back [illegible] past trees, then reversed and rushed at [illegible]



Darting through space in a tiny metal cockpit suspended from the top of a revolving mast the "Airplane Swing" gives riders sensations of great speed and lofty heights. Crowds, eager to spin through the ozone, patronize this thrilling ride

forests, landscapes, and scenes intended to loosely relate. From this it got its name, "scenic." The cars rarely traveled faster than ten miles an hour, and little attempt was made to thrill passengers with sharp dips.

This summer, at Woodcliff Pleasure Park, Poughkeepsie, N. Y., there was opened a new coaster railway which drops its trains down a dip of 132 feet, and at the bottom they are traveling seventy miles an hour! At Coney Island the "Cyclone Racer," new this season, reaches a speed of better than a mile a minute. But even these rides will not satisfy the public long. Already the giant "Mile Sky Chaser," built at Coney Island by Arthur Jarvis in 1924, has ceased to be a sensation. It is not easy to thrill people who often travel at better than sixty miles an hour in their own automobiles!

And the problem of thrilling the public of the future has the amusement device engineers stumped. They admit it. If the past forty years have speeded people from ten miles an hour to seventy, they say, what will the next forty years have to do, to keep pace?

"We've gone about as far as we can in getting thrills out of gravity coasters," Vernon Keenan told me. He is chief engineer of Harry C. Baker, Inc., of New York City, a large builder of amusement devices. "To hold our patrons, we'll have to do the impossible," he added.

And Keenan and others are planning to attempt "the impossible." They believe they may achieve it in future coasters by contradicting the law of gravity—running upside down at times and "leaping the gap"—that is, jumping through space from one track to another. This suggests that the Coney Island "Loop-the-Loop," probably the greatest thriller of all, may be revived in a new form. This device was abandoned in 1911 because of several serious accidents.

"People nowadays like to wave to their friends, and show off. Keenan told [illegible] They want to believe the rides are [illegible] If they think they're in peril [illegible]ment they call the rides 'grand,' [illegible] back for more. Our trick is to [illegible]k, without the danger.

[illegible]ample, the guard straps and [illegible] which we put on the seats of the cars [illegible] really unnecessary. The rides are perfectly safe, or we wouldn't be operating them. But the straps and guard rails suggest danger. "Why this thing is so bad,

The grandfather of all [illegible] C. A. [illegible] [illegible] Thompson [illegible]

Even in the Far East [illegible] Far East [illegible] has not cause dizziness, appeals to eager patrons in a park in Palestine

Here's the latest. The [illegible] workers [illegible]

[illegible]

they had to stop to prospective passengers exclaim—and then buy their tickets.

At certain [illegible] when the trains leave the top of a steep dip, the passengers are actually lifted a few inches from their [illegible]. This produces the sensation of being thrown into the air, which [illegible] pass without [illegible]. But the truth is that the opposing forces are so nicely balanced it is impossible for a passenger to fall out, if he is obeying the rules.

The greatest thriller of all—Coney Island's "Loop the Loop." This device was dismantled in 1915 because passengers fell from their seats while riding upside down and were crushed

THE superlatives given [illegible] No matter what rules we may make he will occasionally insist on being a dare-devil, and sometimes pays the price for it. But, taken on a whole, most of the modern rides, for all of their slamming dips and breath taking swerves, are as safe as the old horse and surrey."

Acceleration explains the feeling of tremendous speed which the fastest modern coasters give. The deception has fooled even automobile racing drivers and aviators, according to Keenan, who told me they never questioned his accuracy when he said the trains attained a speed of one hundred miles an hour at the bottom of the initial dip. This first chute gives the trains sufficient momentum to complete the circuit, and the maximum acceleration is attained in from three to five seconds, following a slow ascent from the loading depot.

The contributions of Jarvis, Baker Keenan, and others have equipped the newest coasters with safety locking devices, by which the trains are held to the guide rails by wheels under the rails and also against their sides, preventing movement in any direction but forward. Back slipping is prevented by safety dogs, which engage in ratchets, on the ascents. Automatic block controls also have been used successfully in some systems, but many operators prefer to trust human guards, stationed along the track, with electric control brakes instantly ready.

The average coaster system is from 2200 to 3600 feet long, and is traversed in one and three quarters to two and one quarter minutes. The most successful of them have carried 10,000 persons in a day, and nearly a million in one year. The completed systems cost from $65,000 to $200,000. Several carloads of the finest fir or yellow pine lumber are required to build one of the structures. Construction of the "Cyclone Racer," at Coney Island, demanded 233,000 feet of lumber, 240 tons of steel, and 96,000 rivets.

CRAMPED building space frequently not adapted for such structures, often forces the drafting engineers to resort to ingenious designs in order to crowd the necessary track length into a confined area. If a building lies in the chosen route of the coaster, the racers have been known both to dive under the building and climb over it. "Funnels" between adjacent walls sometimes concentrate wind on a proposed "hilltop" and must be considered, for such obstacles might demoralize a coaster system by blowing its trains to a standstill. Trouble will follow if a train

[illegible] tracks with the vertical [illegible] coaster rides, has produced [illegible] results. The tradi-onal carrousel, which first appeared in 1867, was probably the pioneer among "flat rides." Later came the "Old Mill" and the "Shoot the Chutes" boat rides, followed by "The Whip" and the "Caterpillar."

THEN, in 1922, appeared the "Skooter," which used to entice electric automobiles, and capitalized the human desire to steer things. These cars operated in roofed enclosures, taking their power through a trolley from an electrified enlarged mesh overhead, and were guided by a track steering arm, which provided plenty of collisions and consequent excitement.

Last came the "Scrambler," using a number of cushioned "tubs," mounted on casters, and placed in a revolving bowl. The opposing gravitational and centrifugal pulls during the "scrambling."

The Football, which appeared in the United States for the first time this season, is a modification and improvement of the Scrambler adapted by E. J. Kilpatrick, New York and London amusement park promoter, from a device he saw in operation at Milan, Italy. Ten tubs, each bearing the name and colors of a famous American college, roll on casters in a forty-eight-foot polished racecourse, which in this device, is stationary, with the exception of a seven-foot inner circle, which revolves. To the circumference of this moving wheel three captive tubs are attached by flexible chains. When in motion, centrifugal force throws the captive tubs from the center, while gravity pulls the loose tubs towards the center, down the sloping sides. Pneumatic bumpers with which the

(Continued on page 127)

Bare Hands

A Story of Men and Science in the Mastery of Northern Wilds

Thurston leaped into the foul smelling hold. There, on the floor, lay his old friend weak and emaciated from weeks of captivity

By

HAWTHORNE DANIEL

Illustrated by J. Clinton Shepherd

THE mystery of Devil Island was a weird and dreadful cry which now and again echoed across its wild rocks. On this desolate northern strand were four castaways. Parker, Thurston, Williams and Kelly. On a pleasure cruise among the Aleutian Islands these yachtsmen had been captured by Kiska Joe, a notorious seal poacher, and had escaped from his clutches only through the shipwreck which had cast them up on the apparently uninhabited shores. Like primitive men, they made their home in a cave and with clubs killed game for food. By their ingenuity they created steel tools from ore found on the island, and even undertook to build an engine-driven boat in which they hoped to escape. Unexpectedly their efforts were interrupted by the appearance of Kiska Joe's schooner. Parker, risking the enmity of the poacher, was made captive. The others, resisting his armed attack, were saved by a repetition of the mysterious cry, before which Kiska Joe fled in terror. The castaways resumed work on their boat. During a feast prepared by Oomak to celebrate completion of the engine, a figure appeared in the open doorway. Seizing a ladle, Oomak struck. The body of a woman fell across the threshold. It proved to be Tuguana, wife of Kiska Joe. Twelve years before, she revealed, Kiska Joe had killed her child. In a struggle with him aboard the schooner she had fallen overboard and had swum ashore. Since then she had lived in a cave on the island. The mysterious cries were her cries of vengeance against the slayer of her child, to whom they were the voice of an evil spirit from the dead. At last the boat was completed and the castaways with Oomak and Tuguana set sail. Now for the conclusion:

KISKA JOE was worried. The last of the seals had only just left Bulde for their annual fall migration to the south and the season had been longer and more successful than usual, yet he was worried. Six times had he slipped undetected up to that uninhabited spot to fill his schooner with seal-skins and now he had a cache that would bring him a royal sum, even though he was underpaid by the crook who bought them from him and slipped them past the customs into Seattle and Portland and San Francisco. But despite his cache of skins his whole season had been one of worry and trouble and danger. Those yachtsmen had been the cause of the trouble, and he was wondering how he might get the ones who were still on Devil Island. Had he only killed them all when he first captured them everything would have gone smoothly enough, for though there had been several searching parties looking for them, no one had guessed at Kiska Joe's connection with their disappearance.

His schooner now was gliding slowly—very slowly—across an almost glassy sea. He was bound eastward for Kiska once more, to get the latest information about the searchers, before sailing for Devil Island and annihilating his enemies. He had recaptured one of them, but the Coast Guard had been so active that he had not dared to sail again for Devil Island for fear a revenue cutter might trail him, and thus ruin all his chances of success. But once he found out where the searchers were and where the revenue cutter was, he would sail to the island and murder every one of the party. He wasn't safe with any of them alive, and he'd better not attempt the job unless he were prepared to get them all.

Though Kiska was his destination, he was not going directly there. He would keep fifty miles to the south of the island, sail well past it, and then turn about, and approach it from the east. If the Coast Guard asked him where he had been, he could tell them he had been to Tanaga or Atka or the Islands of the Four Mountains.

Slowly the sun sank beneath the sharply marked horizon, and when its brilliant rim had passed the edge of the sea, Kiska Joe, if he had looked, might have caught sight of a tiny spot upon the horizon appearing faintly against the bright light of the western sky. The speck was an odd little steamer, strangely out of place in that wide expanse of sea, so far from land. Trans-Pacific liners bound from Japan to Vancouver or Seattle often passed along the route that Kiska Joe was sailing. But this vessel was even smaller than Kiska Joe's little schooner. Its single funnel stood up against the sky without masts to keep it company. Still even if Kiska Joe had seen it, he probably would have given it little attention. His mind was on his plans for his attack on Devil Island and a spot on the horizon, unless, perchance, it had been a Coast Guard cutter, would have interested him not at all.

The sun sank lower still, until the western sky was dark and overhead the stars were out—sparkling and distant. The schooner sailed slowly in the faint breeze—moving well, hardly enough speed for steerage way. The sea slid past as silently as oil and the sails, barely distended by the breeze, suggested listlessly. Kiska Joe looked about casually, and went below.

Into the night the schooner made her way, moving hardly more than three miles an hour. Her running lights were clear red and green, and the binnacle light glowed softly into the blank face of the man at the wheel. Only two men were on deck—the helmsman and the mate, and the mate was enjoying the virulent flavor of his pipe. All at once, on an eddy of a midnight breeze, a faint metallic sound came to their ears. Looking about, they caught sight of a mysterious glare astern of them a mile or so. The light vanished as suddenly as it had appeared, yet the strange clanking sound, faint at first, grew louder. They watched and listened. A thin layer of clouds had obscured the stars, and the night was utterly dark.

In vain the mate searched the darkness for some sign of the origin of that slowly growing sound. He marveled, for he had never seen a ship at night without lights. Perhaps this was not a ship! His heart beat faster at the thought, and the strange beliefs of the Aleuts sprang unbidden to his brain. If it was not a ship, then what? Spirits and devils and strange, savage goblins crowded through his mind. He looked again, but not a thing could he see. Perhaps he had better call Kiska Joe.

But Kiska Joe, once he was on deck, could offer no explanation. The sound was still at some distance. They could gather its direction, more or less, but they could see nothing. The mate ventured to express his thoughts concerning spirits and devils, and Kiska Joe involuntarily started. He had heard white men laugh at such things, but had he not seen? Not once, but many

Tuginoss, too, heard the sound. She rose suddenly to her feet and stood listening on the stern deck, while the glow from the furnace illuminated her figure. "Kuka Joel?" she shrieked. "Kuka Joel I feel you!"

times! His wife, for instance. Many times had he seen her since she had faded from the rail beside which he now stood. He moved away from the spot a little uncomfortable. He recalled the vision of his wife—a vision of streaming black hair, of flashing eyes, of upraised arms and widely spread fingers. He shuddered, for he remembered, too, the fearful shriek that always foretold that she was about to dash toward him. Yes, there were spirits or devils; no doubt about it!

The clanking was nearer now, and he could make out a strange hissing sound as well. He listened closely. Surely it was nothing more than a ship with some kind of an engine that he had never seen before. White men were forever making something new. That must be it. Still, it was strange that the vessel carried no lights. Well, he would hail it and learn what it was.

"Ship ahoy!" he cried, but there was no reply; only the clanking and the hissing. Then, suddenly, he saw a faint glow—a glow of light on something that billowed and rose and fell. What was it? Never in his life had he seen the like before. He quivered with fear. Spirits? Devils? What?

Closer came the sound, and brighter the strange red glare. A shapeless form moved back and forth in the light. He must call again. He must! No harm had come from his first hail. Probably none would come from a second, and it might be only another vessel—a vessel that gave out weird noises and carried no lights.

"Ship ahoy!" he cried again. "Ship ahoy! What ship is that?"

But his blood ran cold at the reply. It began as a low cry that wavered and fell, and rose again, higher and shriller, until it drowned out the sound of clanks and hisses. It wavered, chilling and penetrating, and finally soared into a shriek. Kiska Joe shrank back, and then he heard his name screamed out across the black water

"Kiska Joe!" It was the very shriek he had heard many times before from the lips of his phantom wife on Devil Island. "Kiska Joe—I keel you!"

Then, as if to bear out the frightful threat that came to him from out the dark, he saw, not fifty yards away, the silhouetted figure of his wife—her black hair streaming in the red light that shone upon her from nowhere—her arms upraised—her fingers wide spread. Where, an instant before, there had been nothing but blackness, now he saw this fearful figure sharply etched in the blinding glare

HE CRIED aloud in terror and the man at the wheel let go the spokes and groveled on the deck. Kiska Joe felt the fellow grasp him about the knees. He kicked savagely and the man let go. Kiska Joe did not look to see what the fellow did. He could not take his eyes from the still shrieking, gesticulating figure of his wife, who stood in that brilliant light, surrounded by darkness, and accompanied by the growing sound of clanks and hisses. He cried aloud. He turned naturally to the Aleut tongue, and begged. He shrieked and pleaded, and felt hope once as the distance between him and the nightmare seemed to grow. But once again she approached—approached, though she did not walk. She seemed to stand still, and yet she came closer and closer

* * *

For three days the crudely constructed boat in which the castaways from Devil Island had put to sea had clanked across the smooth water. At the end of the second day the seal-skins of fresh water—all save the one they had reserved for drinking—were empty, and they were forced to use ocean water in the boilers. Yet they kept on their way. They had no compass, so they steered by the stars and the sun, and went sadly wrong when they took Oomak's guess as to the direction they should go. Thus, during the second night they had passed within ten miles of Baldur without seeing it in the dark, and had headed toward the southeast into the almost boundless expanse of the Pacific.

Late in the afternoon of the third day they sighted a sailing ship far ahead of them—a sailing ship that they were gradually overtaking. They determined to catch up with her in order to learn their position, or possibly go aboard, leaving their crude vessel to the mercy of the seas. But steam as they would, night had fallen long before they came within hailing distance, and only by watching her lights with the utmost care could they continue after her.

Ship ahoy!" cried Kiska Joe. "Ship ahoy! What ship is that?" His blood ran cold at the reply. It began as a low cry, that wavered and fell, and rose again

BUT they were gaining. Their engine pushed them surely along their way, and they could see the sailing ship's lights growing larger. They knew that their engine would be overheard before any hail that they could give, and so, seeing that they were surely gaining, the party was taking its ease, despite rapidly pounding hearts and eager desires. Williams had relieved Thornton at the engine, and Kelly had taken the tiller from Oomak, who sat in the stern beside Thornton, while Tuginana sat cross-legged on deck, less interested, apparently, than anyone else, in overtaking the ship.

Closer and closer they came, and suddenly Thornton touched Kelly on the knee.

"Didn't they hail us?" he asked. "Listen!"

Tuginana rose suddenly to her feet, and stood listening in the dark on the stern deck, before the group about the tiller. She too had heard the sound, but no other sound came, nothing but the regular clank of their engine and the hiss of the escaping steam. All they could see was the light from the binnacle of the other vessel, and the billowing clouds of steam from their engine as it wavered, from time to time, across the top of their short funnel, up which, faintly, shone the light from the fires below.

The hail came again.

"SHIP ahoy!" they heard. "Ship ahoy! What ship is that?"

Thornton started to his feet to reply, when suddenly his blood was chilled by Tuginana's shriek. He remained on one knee, wondering what had come over the Aleut woman, who, since she had fallen stunned across the door sill, had been so mild a creature. Her shriek was dreadful. And then—"Kiska Joe!" she cried. "Kiska Joe! I keel you!"

"Good Lord!" muttered Thornton. "It's Kiska Joe! We have to get out of here. Williams," he called softly, "stoke up, for the love of Pete! We've got to get away!"

Williams, who had been watching from the steps that led down to the boilers, instantly swung the furnace doors open and shoveled charcoal madly on to the fires. The light shot out brilliantly into the black night, lighting the still shrieking figure of Tuginana as she waved her hands at the vessel that now was hardly more than forty yards away. Kelly pushed the tiller hard down and the little steamer turned slowly and started away. They heard the voice of Kiska Joe crying out in Aleut, and Thornton leaning toward Oomak grasped the Aleut's arm.

"What's he saying, Oomak?" he asked.

"He think Tuginana spirit come to keel him," replied Oomak. "He think she devil. He say go 'way. He give money, give sea-skins, give anything, only go 'way."

"Kelly," whispered Thornton suddenly, "turn back. Go after him. He thinks she's a devil! Williams," he called, "keep those furnace doors open. Keep out of the light yourself. Keep it on Tuginana."

THE steamer turned once more toward the schooner, and slowly overtook her. They could vaguely see now, the figure on the deck that still cried out fearfully in Aleut. It was Kiska Joe, and Tuginana leaned forward, screeching and waving her arms in the glare from the furnaces. The distance between the two vessels diminished. Thirty yards, twenty, ten. Closer they sailed, and Kelly put the tiller down bringing the steamer to within ten feet of the schooner's rail. They saw Kiska Joe move toward the opposite rail still crying in Aleut. The steamer slid closer still and suddenly Tuginana leaped. She fell across the schooner's rail, and yelling, and climbed aboard.

On the schooner all but Kiska Joe had run below. Only the half-breed captain remained to face the vision of frightfulness that his staring eyes saw. But Tuginana's sudden leap was a terrific shock. He was too frightened to make out the dim shape of the vessel from which she had jumped, and could think of nothing but avenging spirits. He seized the rail behind him. He screamed. The white men on the steamer saw him throw up his hands. They heard a splash—and slowly the schooner moved on in the faint breeze, with no one at the wheel, with no one save Tuginana on deck, and with her captain beneath the smooth water that closed about the vessel's stern.

"He fell overboard!" cried Kelly, turning the boat about to search for him. The schooner glided slowly on, and for two hours the little steamer lay on the calm sea, looking for some sign of Kiska Joe. But they found none. A mile or two to the east the schooner came up into the

(Continued on page 123)

Deck Fans *to Aid* Sea Flyers

A mid-ocean landing in the teeth of a man-made gale. How the proposed wind "brake" would enable a fast ocean-hopping plane to alight safely on a liner's deck. Its fuel supply replenished, the plane would then be sent on its way by a catapult

ARTIFICIAL gales would enable a fast land or water plane to come to rest on a steamship's decks in a plan proposed by Frederick Brunner, a Swiss aeronautical engineer, which is pictured above by our artist. With the Brunner landing device, freight-carrying planes might cross the Atlantic, because they could stop in mid-ocean for fuel and use their entire lifting capacity for carrying cargoes.

On the deck of an ocean liner a wind machine with airplane propellers would create a gust of air of tremendous velocity. The pilot of a freight plane, desiring to land, heads directly into the wind stream. As he approaches, the force of the blast increases, and motor roaring, propeller spinning, the plane actually hovers motionless in the air. Thus an airplane might sink gently on an even keel, straight down into a landing space no larger than its own length.

Brunner and others believe the problem of bringing a moving plane to a standstill within a small space has been solved. At the point where the propelling force of the airplane is equal to the resistance produced by the artificial air current, the plane comes to a stop.

To prevent an approaching plane from pitching and tossing, with possible damage, the "wind machine" sends its blast through a louvre-like arrangement of vanes that keep it uniform and in a straight line. This eliminates air eddies, and would make the landing so smooth that even a seaplane equipped with pontoons instead of wheels could float down without injury upon a liner's deck.

Aeronautically and dynamically the invention is feasible, in the opinion of aeronautical experts. Brunner is awaiting tests on the model he is building.

Although the Atlantic has already been spanned in stages by ships, this feat cannot, at present, be duplicated by a freight-carrying plane. Gasoline load must be sacrificed to cargo, and a freight plane needs, therefore, a mid-ocean gas station where it can refuel. It is to meet this need that Brunner has devised his unique landing device. Only a few feet on a passenger liner's deck, instead of the broad expanse of runway on a modern airplane carrier's landing-surface, is required by a descending plane.

After fuel has been obtained, the air freighter may be picked up by a derrick and placed on a catapult like those in present use for launching planes on ship-board. Its tanks filled, it continues its way across the ocean with its cargo.

Soft-Faced Hammer Saves Your Car

FACED with soft removable plugs to protect such parts as gears, sprockets and polished metal work from injury, the new hammer pictured below is designed especially for work around the automobile. New plugs are inserted as needed, the old ones being driven out by a punch pushed into a unique slanting hole that

The face of this soft surfaced hammer for motorists can be renewed when worn out

is a feature of the tool. The hammer will not lose its balance, as is the case with other soft metal hammers, even after constant use, and will deliver as forceful a blow as any tool of its size.

KNOW YOUR CAR

WHEN you drive your automobile around a corner, the rear wheel on the outside of the curve turns faster than the one on the inside. If there were a solid axle between the two rear wheels, either one of the wheels would slide over the ground or else the strain would snap the axle in two. In order to eliminate this trouble, a different al gear is used in the rear axle and the axle is made in two pieces. As your car starts around a curve the differential gear comes into action and allows one wheel to travel faster than the other without strain. While your car is traveling in a straight line the differential gears are not in operation; consequently, the only wear that takes place on these gears is when you are rounding a curve. In order to make the differential gears last as long as possible observe the following rules:

1. **Keep your foot off the accelerator when you are rounding curves, whenever possible.**
2. **Avoid fast driving on steep hills with many curves.**
3. **Make sure that the axle housing is kept filled with the grade of lubricant recommended by the makers of your car**

N. H. Freeman, British inventor, and apparatus he uses in produce a new, cheap fuel for automobiles

Briton Develops Cheap Fuel

A METHOD of producing a new motor fuel, much less costly than gasoline, was recently reported from England. The illustration above shows the remarkable apparatus used thus far in the laboratory experiments. Commercial apparatus would be two hundred times as large.

The raw material is a cheap grade of coal, and the fuel is obtained as an oil by distillation. When all the oil has been extracted, powdered coal remains as a valuable by-product. In the picture the inventor, N. H. Freeman, is shown taking one of the operations.

New Device Rectifies Current

A THIN disk of reddish copper oxide is said to be the secret of a remarkable new invention. Without use of an electrolytic cell or rectifier tube, it rectifies the alternating current from your house wires to a one-way direct current suitable for battery charging. It is possible that the disk, made on a large scale, will eliminate rotary converters in electric power stations, according to the inventor, Prof. S. J. M. Allen, of the University of Cincinnati.

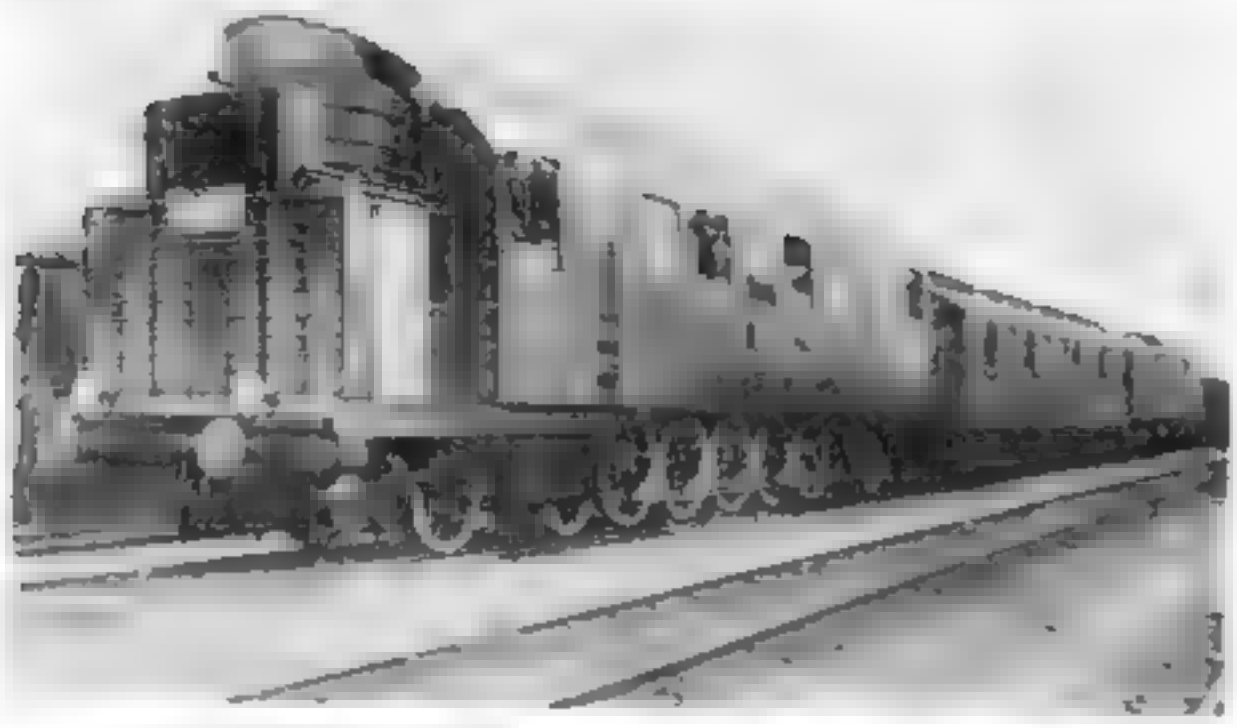
Traffic Tower in a Hotel

GUESTS at a new Berlin hotel are enjoying the novelty of what is probably the most elaborate electric information and control system of its kind in existence. When you arrive at this hotel a traffic officer in a booth all his own takes charge of your movements. Elevators under his command speed you to the proper floor, by the time you reach it you have been announced by telephone. House detectives have been dispensed with; for through the traffic director's indicators he is aware of everything that occurs in the hotel.

France Tries Iron Roads

ROADS of iron are being tested by engineers at Le Mans, France, who have paved a part of a main highway, the Avenue Leon Bollee, with ten tons of cast iron plates. The plates as designed by the government's chief of road engineers present a slightly corrugated nonskid surface, having the advantage of being smooth for motor cars, yet rough enough to prevent horses from slipping. Besides their obvious durability, they afford a new use for old iron.

Professor Allen is shown holding a disk of his new alternating-current-rectifying metal



This queer-looking locomotive, designed for use on German railroads, burns oil as fuel

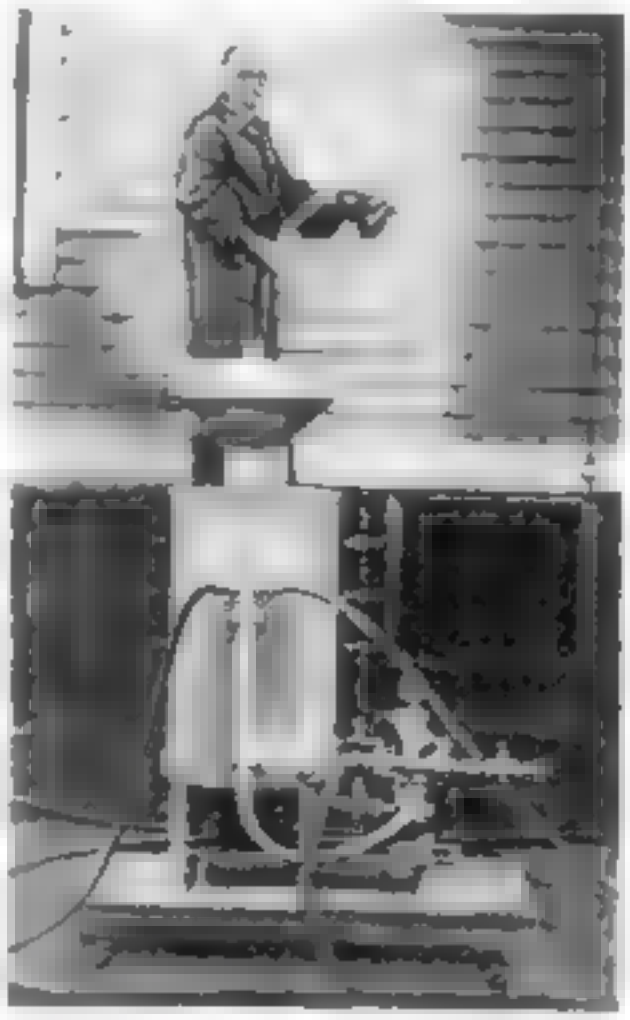
Locomotive Burns Oil

"LIQUID coal," a synthetic oil fuel obtained with the aid of hydrogen gas from the lowest grades of coal, is used in a remarkable locomotive just completed in Germany. Prof. Lossenssoff Russian engineer, designed the new 1400 horsepower engine, which runs by a Diesel motor—a gasoline engine turned oil burner. The photograph, taken during the trial trip near Berlin, shows the curious apparatus at the front with its enormous vent that serves as a radiator to cool the motor. Enough fuel is carried in the engine's tanks for a 2,000-mile run. As the locomotive is smokeless, there are no cinders to blow into passengers' eyes.

Counting Cash by Electricity

MONEY flows like water at the Bank of England in London where a novel electric machine sorts and counts silver coins and discharges them into bags hung beneath. Amounts of from five to a hundred pounds sterling are automatically allotted to the proper receptacles. Far more rapid and infallible than a human hand, the device measures out the equivalent of $7,500 in an hour.

Coins are sorted and counted electrically by machine in the Bank of England, London

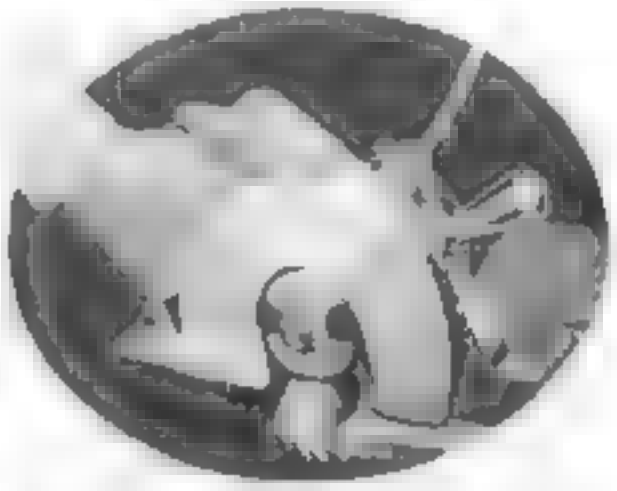


Houses Washed by Machine

TWO men can wash an average-sized frame house in five hours, with the new electric machine pictured above. A motor in its base automatically mixes a cleaning solution from powder in the conelike hopper and forces it through a hose to the sponge in the operator's hand. He need only rub the sponge lightly along the wall, and the dirt vanishes. By turning a valve, the cleaning solution is shut off and water alone used for rinsing. In a few hours, using this process, it is said, your house looks as new as if it had just received a fresh coat of paint.

Radio Aids Treasure Hunt

ARMED with a Government license and a new radio device said to indicate the presence of large quantities of buried metal, a party of American and British adventurers is reported to have made the first recorded discovery of buried treasure in paying quantities. The "find" was made recently in Panama City, where jewels, plate, and chains of precious metal were said to have been brought to light. Pirates' hoards in the West Indies, the Florida keys and the Mexican coast will be searched for if the radio treasure-finder meets with further success, as well as two spots called the world's greatest treasure fields—Cocos Island, off the coast of Chile, and a small volcanic island off Brazil.



Ten-Pound Electric Handsaw

ONE slow stroke with the new motor-driven handsaw pictured above, and a board is sliced neatly in two. The whirling blade, mounted directly on the motor shaft, does the work in a tiny fraction of the time it would take to saw a piece in the old hand way. Light and portable, the tool weighs only ten pounds. One of its useful features is an adjustable depth gage that can be set for a cut of any depth up to two inches.

How Much Do You Know of the World You Live In?

TEST yourself with the twelve questions below, selected from hundreds sent in by our readers. If you can answer half of them, you are doing better than most. For the correct answers, turn to page 135.

1. What is El Capitan?
2. Who were the mound-builders?
3. Where do seaskins come from?
4. Where was "El Dorado"?
5. What is ambergris?
6. Where is the world's coffee grown?
7. Why are Irishmen called Hibernians?
8. Where do sandstorms sometimes blow away the railway?
9. Where do explorers find ancient books written on clay bricks?
10. What country averages more than two miles above sea level?
11. What island contains giant stone statues built by a mysterious race?
12. Where does vanilla come from?

Magnet Saves Workers' Eyes

IT'S NO joke to get a fragment of steel in your eye; but the sufferer in this pict ure was unusually fortunate. He is having it removed by a remarkable new "ring magnet" developed by English physicians, that enables them to draw the metallic splinter into an accessible spot where it can easily be extracted. Counterweights support the heavy mechanism while the patient places his head within the powerful magnetic field.

Poisons More Dangerous to Women

WOMEN workers are more susceptible than men to poisonous substances used in factories, according to a report prepared by Dr. Alice Hamilton, professor of industrial medicine at the Harvard Medical School, who points out that they are the first to succumb both to familiar poisons and new poisons used in industry. In fifty-two recent cases of poisoning caused by fumes of benzol now used on a large scale as a rubber solvent, forty were women.

During the war, says Dr. Hamilton, women in munitions factories were more liable than men to poisoning from materials used in making explosives. With new and unfamiliar poisons being used, particularly as solvents for varnishes and shellac, it is important to safeguard women, Dr. Hamilton says, as experiments have shown that a poisoned woman may have poisoned children.

Radio Lights to Guide Airmen

RADIO signals from the ground direct aircraft in a unique adaptation of the automatic dial telephone, invented by Capt. Paul S. Edwards of the U. S. Signal Corps aircraft radio laboratory at Dayton, Ohio. Any one of a hundred different code signals, consisting of numbers, can be sent from the apparatus, which resembles the dial of an ordinary automatic telephone. In the pilot's cockpit aboard the airplane, flashing lights on a visual indicator interpret the signals to give the airman directions for landing in a fog, or for plotting the course of his flight. The visible signals are not interfered with, as ordinary radio signals might be, by the tremendous roar of the motor.

Electricity Hastens Crops

ELECTRIC wires embedded in the soil have been successfully used to produce farm crops ahead of time, according to recent reports received from Sweden by the United States Department of Commerce. Its soil warmed in this unique way, a farm near Stockholm secured a fine crop of lettuce in March, far ahead of the usual season. In further tests to be conducted at the Stockholm Agricultural Experiment Station a half-acre open field will be strung with buried wires 150 feet apart. Scientists believe that they will then be able to plant potatoes in April and harvest them in early June.

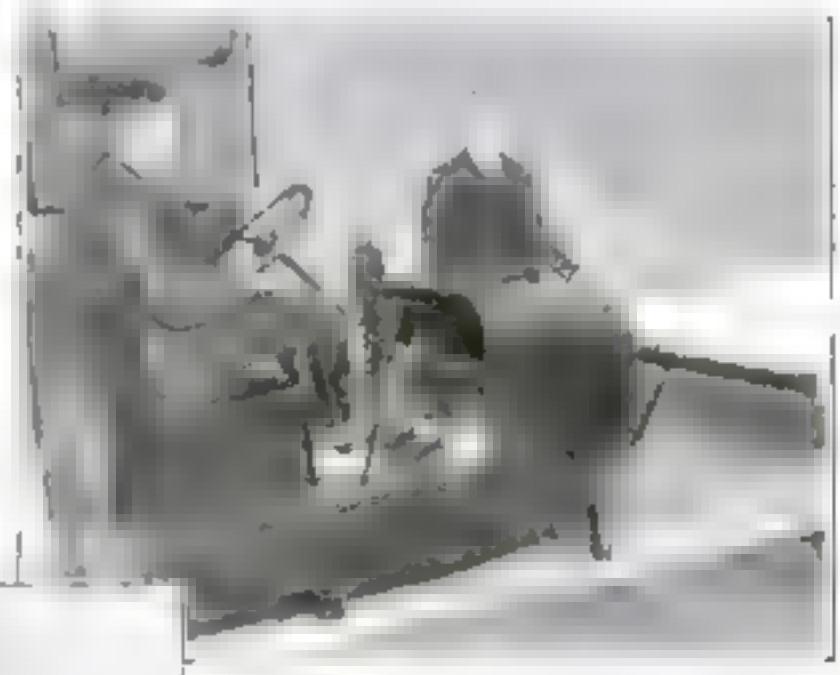
Capt. P. S. Edwards, U. S. Signal Corps, demonstrating his new signaling system for aircraft

Flame "Burns" Under Water in New Steam Boilers

NOT only does a flame "burn" under water, but it heats the water with amazing efficiency, according to the inventors of a revolutionary new type of steam boiler. A Swedish engineer, Oscar Brunler, and his son have perfected its salient feature—a burner that forces a burning mixture of air with gas, oil, or even powdered coal straight down into the water in the boiler! Combustion is complete before the flame strikes the water, but the hot gases are still glowing as they speed through it to raise even cold water to steam in a few minutes. At Hanover, Germany, a 500-horsepower boiler fitted with the underwater burner has successfully completed a year's tests.

Two English inventors, C. F. Hammond and William Shackleton, have also perfected a "submerged-flame" boiler. Both this and the Swedish invention need no smoke-stacks, for there is no smoke. The boilers need be only one tenth as large as usual, as an ordinary boiler of equal capacity—an important space-saving feature on ships, where every inch of available space is needed.

ARTIFICIAL heating for the ocean is to be tried out at Westerland, Germany, a popular seaside resort, in order to prolong the year-round bathing. Huge electric heaters will be installed that will raise the water's temperature and rob a winter dip of its chill. Heated bathing cabins and covered ways leading to the water will be provided for the bathers' comfort.



Movies Test Auto Drivers

TO DETERMINE who is, and who is not, competent to drive an automobile, and to help lessen the mounting toll of traffic accidents, ingenious tests for prospective drivers, using motion pictures, have been developed in Germany.

In the testing room is a model driver's seat, equipped with all the controls used in operating an automobile. The person to be tested is seated at the steering wheel. In front of him is placed a screen, upon which is thrown a motion picture of a congested street, showing moving autos, pedestrians, traffic signs and so forth. He is required to operate the controls so as to avoid the "dangers" and obey traffic rules. Every mistake he makes is registered automatically on an electrical recording machine.

Dredge for New York's Bridge

THE largest dredge of its kind in the world had to be used in the first underwater excavation not long ago for the foundation piers for the great Hudson River bridge linking New York and New Jersey. Sixty thousand cubic yards of mud, the engineers estimated had to be lifted out of the river bottom on the New Jersey side alone and the mammoth dredge scooped out the cavern at the rate of thirty-two cubic yards to each swallow of its steel maw. The New Jersey foundation, it is hoped, will be above water level before the cold weather sets in

Blueberry Cure for Diabetes

SIX out of eighty-one diabetes patients treated with myrtillin, a new drug made of blueberry leaves, have been cured, according to a report by Dr. E. M Allen, of Morristown, N J., to the Association of American Physicians Twenty-six cases, he says, were benefited positively while twenty-one cases were outright failures. Myrtillin, Dr. Allen emphasizes, is to be regarded as supplementary to insulin in the treatment of diabetes.

How Apes Might Talk

A CHIMPANZEE might be taught to talk with its fingers, as deaf people talk, more easily than it could be taught to imitate sounds of human speech is the opinion of Dr R. M Yerkes and Margaret S Child, psychologists, of Yale University

"Perhaps the chief reason for the apes' failure to develop speech is the absence of a tendency to imitate sounds" Dr Yerkes suggests in explanation "Seeing strongly stimulates imitation, but hearing seems to have no such effect"

A French scientist, Louis Boutan, who observed a female gibbon for five years, has concluded that a young child who has not learned to speak, works like a gibbon. A child who is beginning to talk no longer works like the ape but directs its efforts along a definite line, like a man.

Portable Reading Lamp Holder

NO MATTER where you go, a new electric fitting developed in England always provides you with an adjustable reading lamp. Its rubber-tipped, movable "feet" grasp the back of a chair or the edge of a table, and a hinged arm holds the light in a position where it will best shed its rays on the pages of your favorite book. The attachment folds up, and can easily be tucked in the pocket or hand bag. It should prove useful to traveling salesmen in hotels without table lamps.

Aid for Deaf Has Tone Control

IF YOU are hard of hearing, a sensitive [illegible] on a new invention does the listening for you With a portable case the size and shape of a small box [illegible] it transmits what it hears to an amplifier that magnifies the sound. Head phones that slip over the ears [illegible] sound medium [illegible] like those used [illegible] batteries to operate the amplifier on the compact outfit An interesting feature of the [illegible] is a tone control which makes it possible to fit accurately an instrument for almost any case of subnormal hearing.

Wooden R. R. Ties Passing

THE familiar wooden railroad tie will soon be a thing of the past, judging from several recent successful experiments to replace them with bars of concrete or steel Sample ties of steel made of scrap metal from worn rails, were installed a year ago in railroad yards at Glenville, N Y. Have proved so successful that they are now to be made in quantity, to replace wooden ties in yards and sidings. Ten times as strong as wood, they are made from the discarded rails at extremely low cost

Meanwhile, after tests extending over a score of years, a concrete tie has been developed Twenty-five thousand of these new ties are being installed over a line near Pittsburgh—enough to cover seven and a half miles of track. Reinforced with steel rods, each tie has wooden blocks set in it to which the track rails can be spiked down.

In the future, engineers predict, roller bearing trains will travel at extremely high speed without vibration, over the new roadbeds

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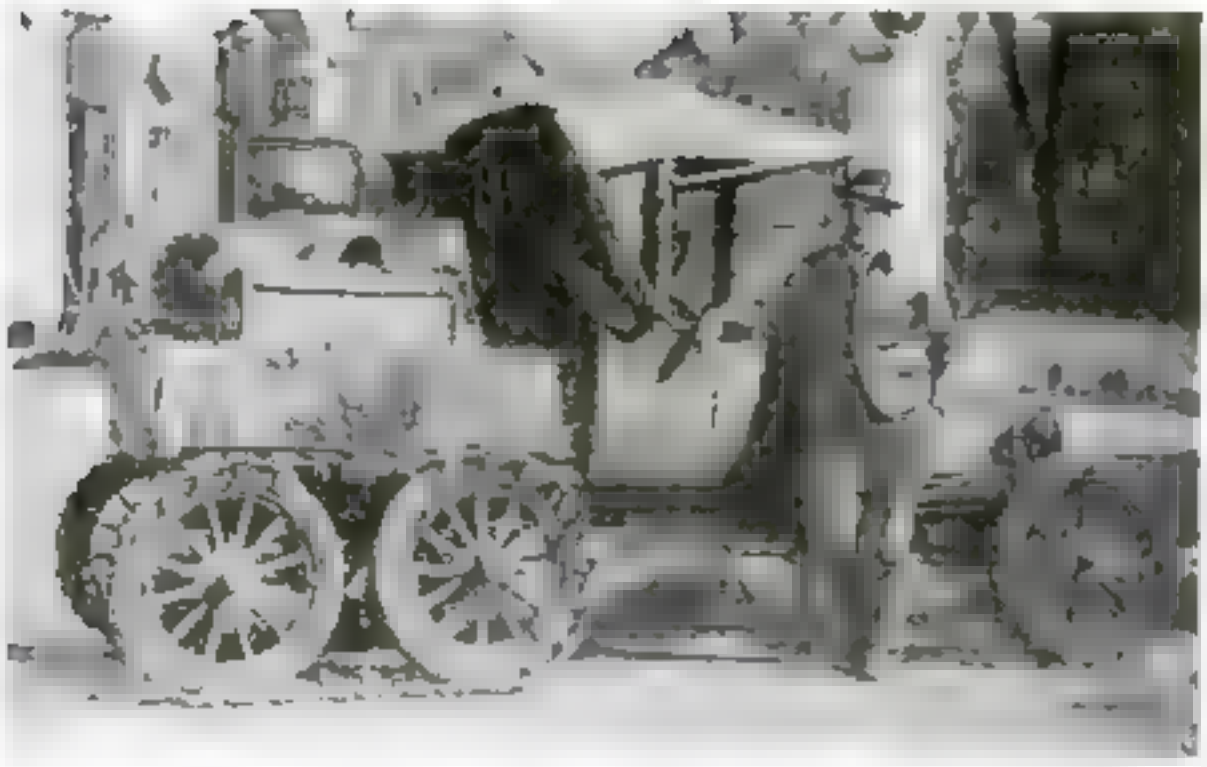
GERMAN POLICE are reported to be using an amazing new device to aid in tracking down criminals an "ultra-whistle, that summons police dogs without giving the faintest audible sound to warn the fugitive The sound wave it emits is of more than 40,000 vibrations a second—too high-pitched for the human ear to hear, but the dog's sensitive ear it is said, detects and understands it

Map Puzzle Teaches Children Geography

This novel toy keeps children busy and teaches geography at the same time. When assembled it forms a handy globe map of the world.

GEOGRAPHY becomes a fascinating game to the child, instead of a dull "bookish" study, in an ingenious and practical new toy. Cupped round blocks each contain the map of a continent, cut up to form a picture puzzle. In assembling the puzzle, the child learns the continents of the world, the countries in each continent, and the shape and geographical location of the countries. When fitted together it forms a serviceable globe.



Mud No Terror to This Car!

IT TAKES a muddy road indeed to stop Leonard F. Muhlheim, rural mail carrier of Delwein, Iowa, and his remarkable car, which he has nicknamed the "Iowa Mud Hen." After he had become marooned countless times with his old car, following rains that made the dirt roads in the southern and central portions of his state almost impassable, he resolved to build an outfit that could conquer the most slippery highway. The "Mud Hen" was the result; its double wheels with their "caterpillar" tread of chain carry him over any road.

Water Purified by Rays

OUT of France's war efforts to provide her soldiers with chemically sterilized, yet palatable water, has come a remarkable new system of purifying city water, already in use in half a dozen French towns. Reported to be economical and automatic, it is the discovery of Philippe Bonan-Vanilla, remembered in America chiefly in connection with the Panama Canal.

M. Bonan-Vanilla discovered an entirely new principle when he found that a minute quantity of hypochlorite of soda, placed in water that was agitated, gave off traces of extremely active chlorine gas when the water was treated with ultra-violet rays. Although the gas was not present in sufficient quantity to cause an objectionable taste, it was powerful enough to kill five sixths of the microbes in a test sample of street gutter water.

To utilize the discovery he developed an automatic pump which does the work of purification in a single operation. French towns using the apparatus report a direct decrease in typhoid cases.

Building Stone Waterproofed

WATERPROOFING stone is the unique method now becoming widely adopted to protect buildings and statues. The stone is heated with a blow-torch to expand its surface and "open its pores." Then melted paraffin is applied with a brush, forming a protective covering against rain, frost, and gas fumes in the air. One such "waterproofed" structure is the Buckingham Memorial Fountain nearing completion in Chicago.

Feeds Movie Film at High Speed

A NEW movie camera mechanism, said to feed film through the camera at high speed without danger of tearing it, is the invention of Edward Anet of Los Angeles, Calif. He claims to have perfected a system of advancing the film after each of its sixteen "shots" a second that grasps it gently, speeds up as it moves it along, and then releases it. The device is also used at superspeed work.

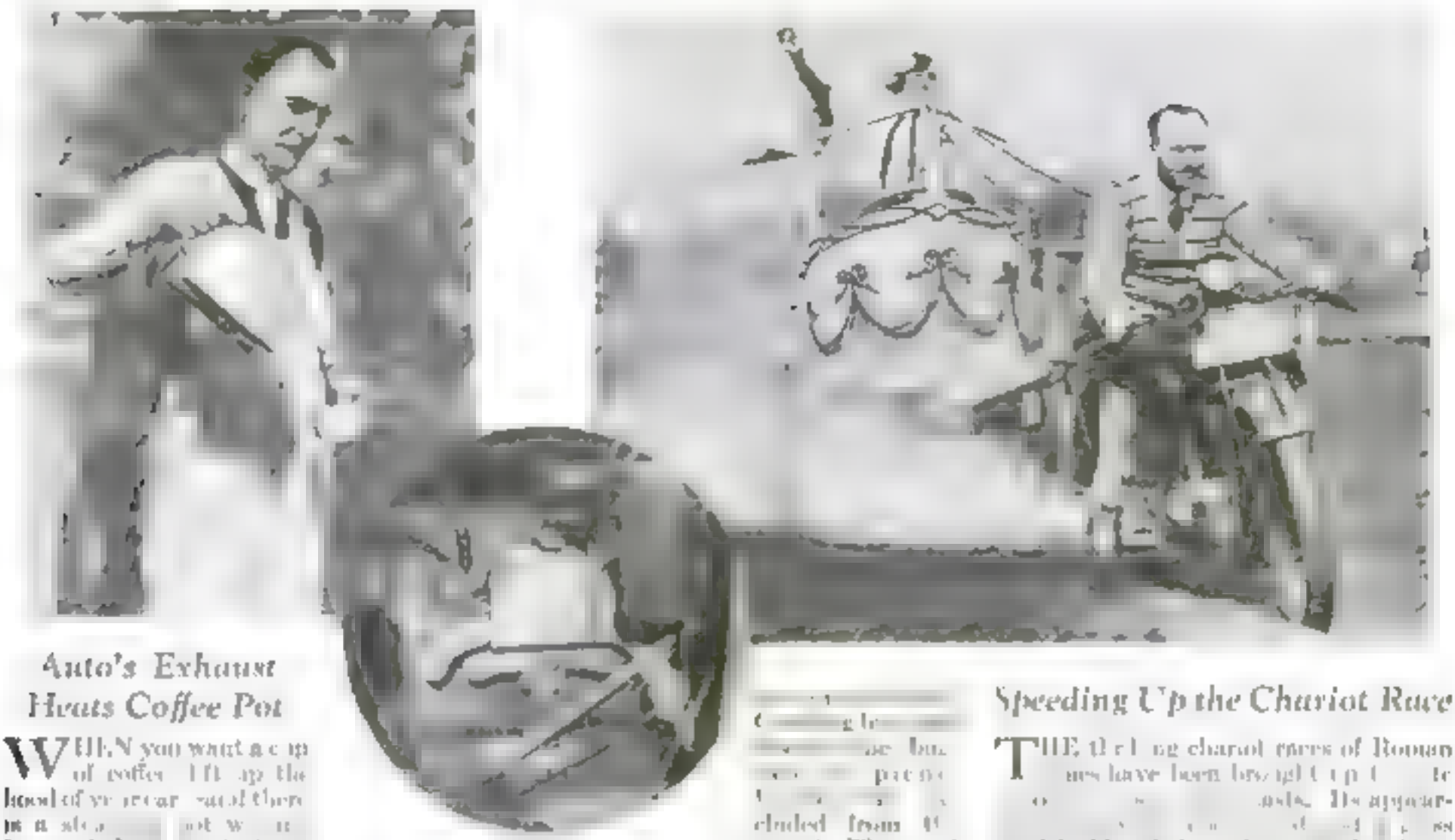
R. R. Gates Direct Traffic

TRAFFIC at dangerous street intersections will be regulated by gates similar to those at railroad crossings, if a novel "silent policeman" invented by George Holmes, of Detroit, Mich., and recently demonstrated in that city, is generally adopted. It carries two pairs of gates, which allow traffic to proceed in only one direction at a time. When the gates that guard one of the intersecting streets are raised, the others are automatically lowered. At corners where no traffic officer is on duty the device would be operated from a distant control point.

Twin Engines Drive Novel Bus

THE motor stage below, recently put into service in Oakland, California, looks more like a trolley than an automobile. There's no danger of a breakdown because of motor trouble, as the bus has two powerful engines, placed under the seats, either one able to drive the machine alone. One is connected to each of the rear wheels, and ordinarily both are used at once, synchronized by a double foot throttle. The "motorman" sits in a cab-hyde at the extreme front, with nothing to obstruct his vision.

This bus has two engines, each with its own radiator, clutch and ignition system, placed under the seats to give more passenger space. If necessary it can operate with one motor



Auto's Exhaust Heats Coffee Pot

WHEN you want a cup of coffee lift up the hood of your car and there is a slot waiting for you! It's easy to brew coffee and drive at the same time with a new coffee pot invented by L. W. Wallace, of Los Angeles, Calif., which fits directly over the engine's exhaust manifold. The heat generated by five to ten miles of driving at ordinary speed the inventor says, is sufficient to boil a pot full of water. On a motor camping trip you can stop for refreshments without the inconvenience of building a fire, eliminating also the danger of forest fires from burning embers left behind.

Lunch Kit and Table in One

HERE'S a compact lunch kit that adds to the pleasure of auto picnicking. After all the food and crockery necessary for a meal has been unpacked from the capacious container, the lid is folded back and four hinged legs swiftly convert it

[illegible] repast. The novel ruse, which is a British invention, folds again after the meal into a surprisingly small space for packing on the running board or in the tonneau of the car.

That Mythical "Sea Level"

ANOTHER popular belief is shattered by the report from Washington that after all, the sea isn't level at all but is a "gently sloping hill." H. G. Avers of the Coast and Geodetic Survey made this announcement after extensive experimenting. The mean sea level at Biloxi, Miss., he tells us, is two centimeters below that at Galveston, Texas. Even more surprising is his report that the mean sea level at St. Augustine, Fla., was found to be twenty-four centimeters below that at Galveston and thirty-one centimeters below that at Portland, Maine!

Speeding Up the Chariot Race

THE thrilling chariot races of Roman days have been brought up to [illegible] windshield added, as shown in the above illustration, the two-wheeled vehicle from which ancient Ben-Hur lashed four horses is now driven by a roaring motor vehicle. Behind their gasoline-driven steeds, the modern "charioteers" furnish spectators a race replete with thrills.

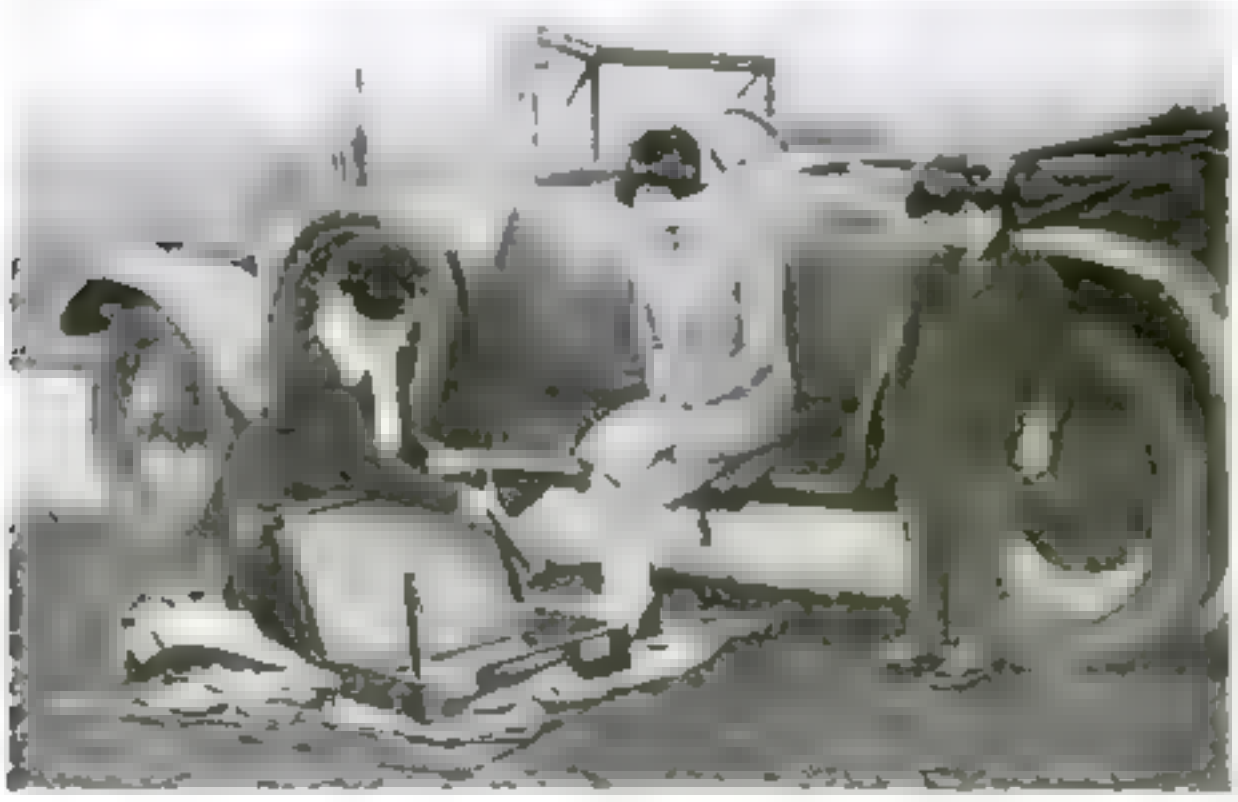
More Power from Less Coal

ONE kilowatt-hour of electric power—enough to burn an ordinary electric lamp for seventeen hours—from a single pound of coal is the striking engineering achievement announced by the Columbia Gas and Electric Corporation, of Cincinnati, O., for their new power plant. This is about one fourth of the energy that scientists say the coal contains, but to recover even this much is remarkable. When coal is burned to give electric power, most of its heat goes up in smoke or is wasted elsewhere. One fifth, or less, of its potential power is usually turned into electric current.

"Superpower" for Airplanes

DEVOID of gears, crank shaft, and timer, a new barrel-shaped rotary airplane motor for which phenomenal power is claimed has been invented by Elbridge Gerry Smith, airplane motor engineer, and the first complete motor is now under construction at Garden City, Long Island. His original model, built during the war, Smith says, convinced him that the new motor would produce two horsepower for every pound of its weight—making it four times as powerful as the best engines now available.

WITH INTENSE artificial light that rivaled sunshine, O. Munerati, French zoologist, recently succeeded in growing three generations of beets in a single year. The powerful illumination caused the plants to go to seed more rapidly, and the seed to germinate in far less time than usual.



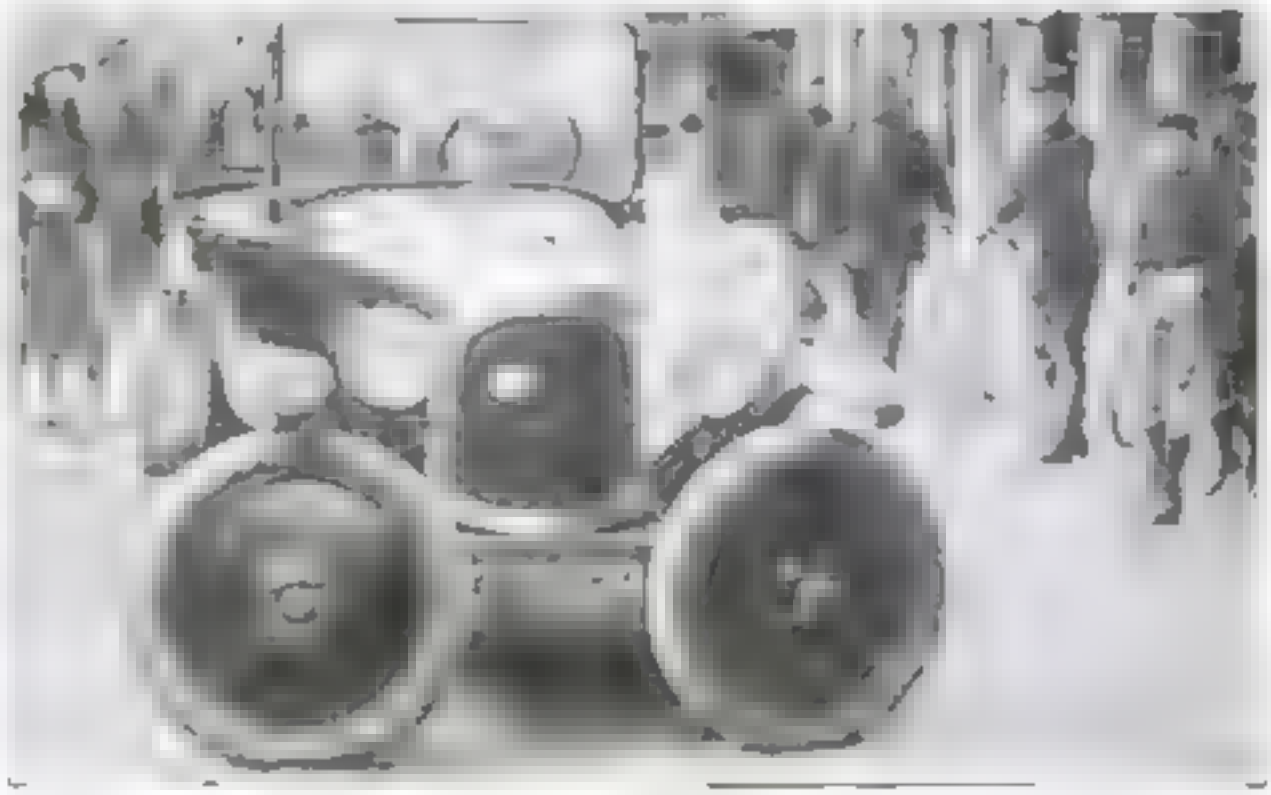
Open this compact automobile lunch kit, remove its contents of food and utensils, and four hinged legs turn it into a table. When packed, the kit is easily stowed in a small space in the car

Inventors' Ideas,

An Odd Quick-Parking Auto, Dust Masks to Fight City Germs, Mechanical Pipe Smoker, and Other Ingenious Creations

The back seat of a theater or auditorium is brought within easy hearing distance of the stage by this novel "ear lorgnette," a novel sound amplifier which magnifies voices just as opera glasses magnify faces

The real angler in this case was not the man in the picture, but an "automatic fisherman" consisting of a large reel containing a coil spring. When a fish bites, the jerk releases a trigger, causing the spring to haul in the catch. A bell signals that the fish is hooked



Sliding into a tight parking space or getting out of a bad traffic jam are comparatively simple matters in this curious auto, recently demonstrated in Paris, for its front wheels can be turned entirely around. The auto can "about face" in its own length

A Minnesota inventor makes the alarm clock switch electric lights on or off at the desired hour. The invention can also be used to control other electrical devices

Now amateurs can make their own movies indoors without need of expensive studio equipment. Plugged into any lamp socket, this six pound portable arc light supplies about the rich evening daylight. It may be held in the hand or suspended from a hook

The latest eccentricity of women's dress is this odd high- waisted sarcenet of velour, which really serves as a dozen different costumes in one. It can be shaped into any style

An ingenious new substitute for the compass saw is this saw guide which can be locked at the desired angle to the piece of wood to be cut. The guide both swings and tilts, permitting the easy cutting of compound bevels

Novel *and* Useful

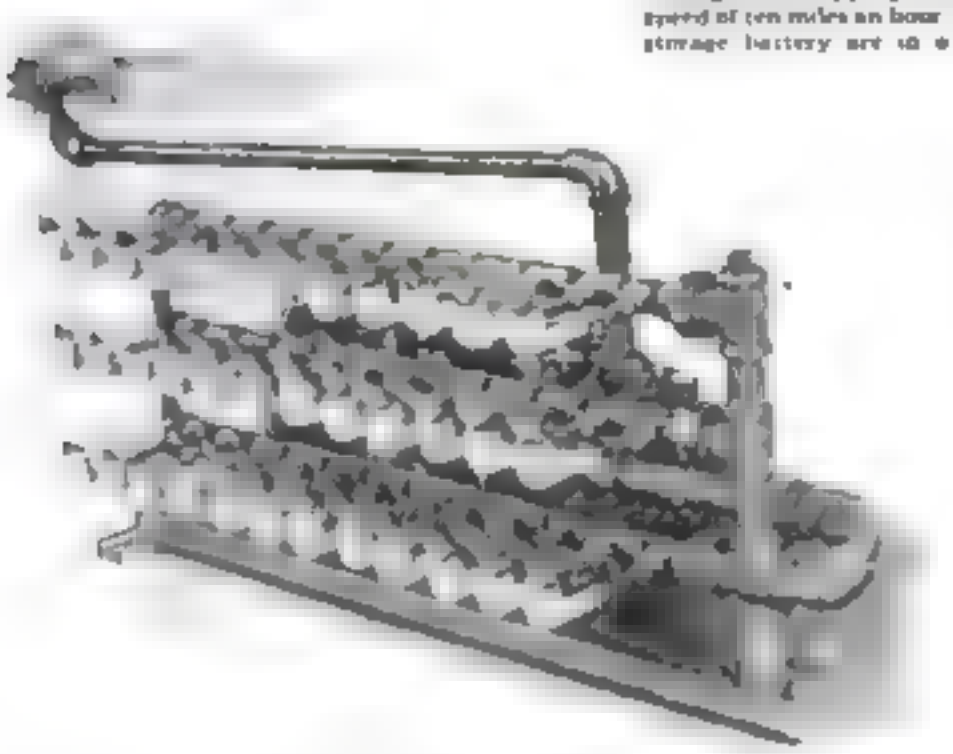
An ingenious life saving suit, designed to keep a shipwreck victim afloat for hours, has an inflated jacket and a helmet with window and breathing valves

Donning the life saving suit. It is in three sections: trousers and jacket of rubber material, and helmet. These are fastened together by locking rings that form water tight joints. The suit serves to retain the warmth of the wearer's body

The latest idea for shoppers is an odd three wheeled electric car. You enter through a swinging front door, touch a lever and glide through the shopping district at the leisurely speed of ten miles an hour. Electric motor and storage battery are in a rear compartment

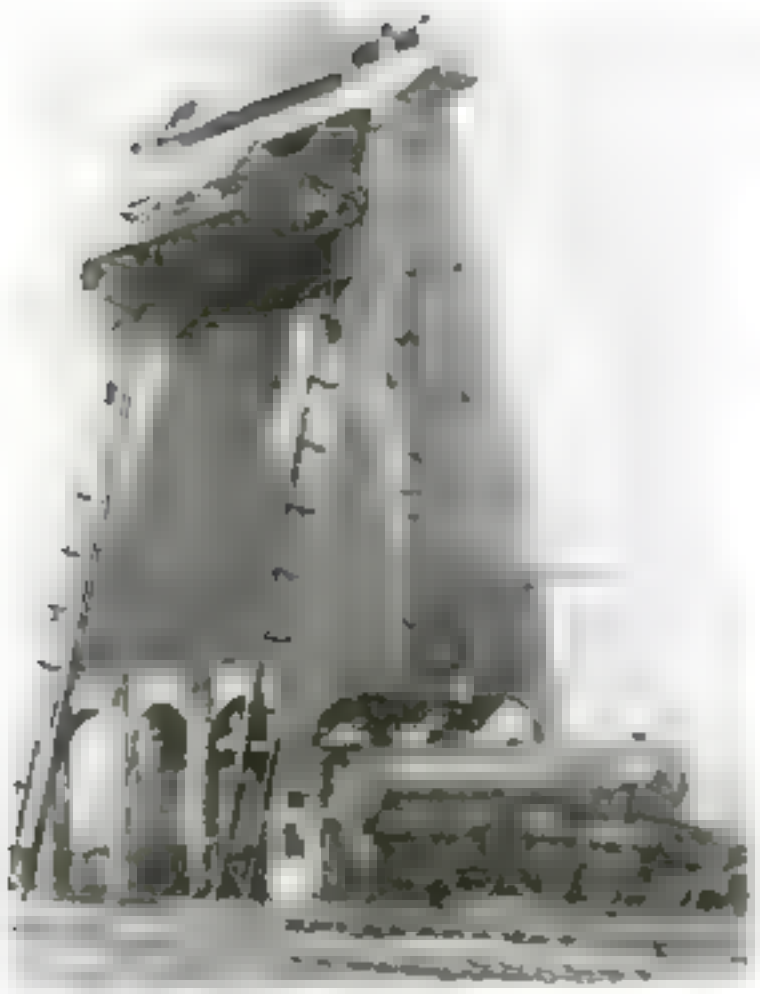
As a safeguard against contagion in germ laden city air, the use of this novel dust mask has been suggested by the Bureau of Industrial Hygiene of New York State. It can be folded and carried in a small handbag

With the machine pictured above traffic lines can be painted on the street as easily as a map can be walked. A pressure tank forces the marking liquid through the nozzles while a canvas roller on the wheel serves as an emergency brake



A machine that can smoke three dozen pipes at once now saves the smoker the distasteful chore of "breaking in" a new briar or meerschaum. Equipped with mechanical mouth and lungs, it "ages" a pipe in a way that would ordinarily require weeks of steady use

On the theory that a monotonous droning noise will make you drowsy, a German inventor has devised a machine to cure sleeplessness. At the right The apparatus, wound up like a clock, emits a soft humming noise which continues for forty minutes



A coal car, hauled to the top of this tower, dumps its load into the waiting locomotive tender beneath

Coaled in Four Minutes

BRITISH locomotives are loaded with coal in an incredibly short time, at a remarkable coaling tower recently erected at Doncaster, on the London and North Eastern Railway. By electric power a coal car is hoisted from an adjoining track, hoisted in a jiffy to the top of the structure, and dumped. The coal, pouring into a hopper, slides down chutes to the tender of the locomotive below.

From start to finish the operation takes only four minutes. At a switchboard within a control cabin that tops the coaling tower, a single operator controls the electric mechanism.

"Wing Flutter" Wrecks Planes

"WING flutter," a curious airplane phenomenon somewhat resembling the "shimmy" of an automobile's front wheels, is the cause of a whole series of mysterious airplane accidents in England, according to a new theory advanced by British air experts to account for eighty unexplained wrecks last year. In many cases the plane, flying normally, suddenly went into a spin and crashed. Apparently the pilot had fainted, or had lost control.

At high speed, scientists now suggest, treacherous air pressure on the ailerons, or balancing flaps attached to the rear wings, may twist the wings themselves and set up vibrations that jerk the control stick out of the pilot's hands. This so-called flutter was noticed in the early days of aviation when the wing [illegible] ailerons were purposely warped for [illegible]. Subsequently "parallel ailerons" were provided but at modern speeds of 120 or 130 miles an hour even these may distort the main wings. To an observer on the ground a pilot struggling with a "wing flutter" might be engaged in a life-and-death fight to recover control.

Overheated Engine Stops Itself

THE "thermostop," a recent French invention, is said positively to protect motors of all kinds from overheating. Should the bearings run dry of oil, the cooling system fail to function, or any other part overheat, the new device automatically rings a warning bell and shuts off the engine.

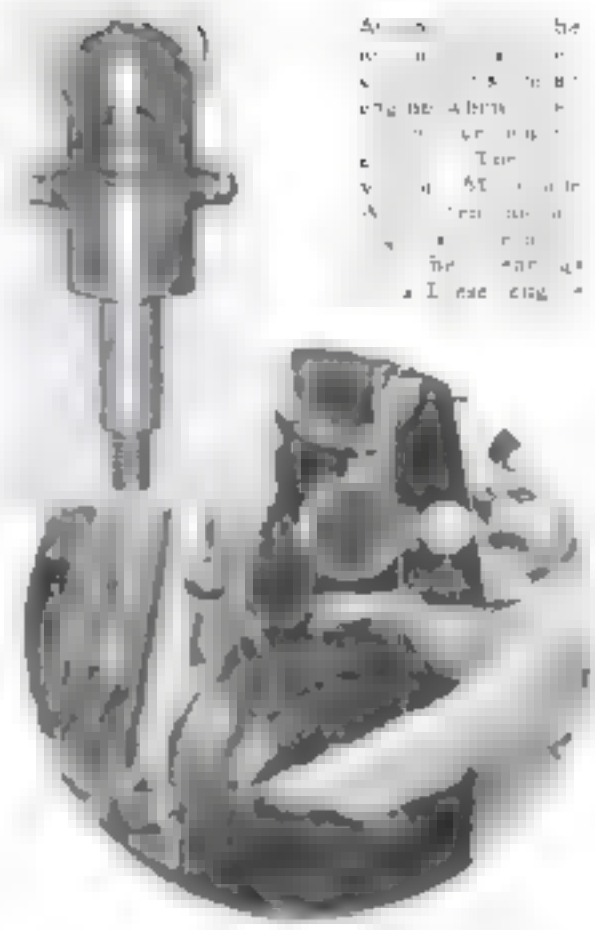
The brains of the device consist of a small dome containing an electric switch held open by a link of easily melted material. Any number of these domes can be used, screwed into the motor at vital spots. When overheating occurs, the fusible link melts, closing the electrical contact and actuating the bell and the motor cut off.

In tests made by the inventor, Emile Airic, an automobile motor was run with the device attached, and the oil supply repeatedly shut off. Each time, he reports, the new device stopped the motor before the bearings had been damaged. His invention makes it safe, he says, to run large steam or Diesel engines virtually without the attention of an engineer.

Test Cigarette Fire Danger

WHEN you throw away a burning cigarette stub, are you contributing to the annual fifty-million-dollar fire loss for which smokers are held to blame? Scientists of the U. S. Bureau of Standards now are making tests to find out how dangerous a lighted cigarette is as a potential fire menace.

In one of the tests, a burning cigarette is placed within a wad of paper and held in the breeze from an electric fan, while an observer with stop watch and clock notes the time required for ignition. This and other tests already have shown that the paper used in the manufacture of cigarettes can be impregnated with substances that will reduce the fire hazard.



Signal Stops this Elevator

ELEVATORS of the kind that often pass by your floor without stopping are being replaced in a thirty-eight-story New York office building by cars that stop automatically on signals from waiting passengers. They cannot pass a floor from which a signal has been given unless they are full; in that case the operator presses a "passby" button, and the next car stops.

Upon entering one of the new cars, the passenger calls his floor to the operator, who presses a corresponding button. The car stops automatically at the desired floor, and opens its doors.

Since statistics show that seventy per cent of all elevator accidents are due to tripping while entering or leaving cars, the new elevators also are equipped with self-leveling devices.

ZEPPELIN Sale's huge dirigible, *Los Angeles*, is being equipped with the new radio apparatus for receiving weather maps, invented originally by C. Francis Jenkins to warn ships at sea of storms.

To measure the hazard of a burning cigarette, the experimenter places it in a wad of paper, turns on an electric fan, and records the time it takes for the paper to ignite

A New Way to Open Letters

HERE'S a handy new device for the desk or writing table. A single stroke, and it opens an envelope neatly and speedily. The unusually narrow strip it saves from the edge of the envelope prevents injury to the letters contents. A thin slot running lengthwise along the handle, and small cutting wheels that fit the slot, accomplish the feat. The cutters are said to last indefinitely, if not misused.

Aerial Car Paints High Electric Cable

ONE of the strangest acrial railways in the world was recently devised to paint the giant electric power cable that spans "The Narrows" of Puget Sound near Tacoma, Wash. Engineers constructed a simple car that carried a paint reservoir and a set of circular brushes to apply paint automatically. Two nervy workmen took turns cranking a handle that propelled their swaying car by turning a rubber-faced wheel in contact with the steel strand from which they hung. The perilous trip of more than a mile at a dizzy height was made in four and a half hours. So effective was the remarkable car that to reach its starting point for the trip in mid-air it crawled by hand power up the precipitous slant of an anchor cable to the top of the 317 foot tower. Had the driving mechanism slipped, the men would have been hurled to almost certain death.

Mammoth Tool Bores 13-Foot Cylinders

ENGINEERING genius has succeeded in producing a giant among machines, a boring tool that can handle monster cylinders measuring up to thirteen feet in diameter.

This iron Hercules, recently exhibited at Leipzig, Germany, is used to manufacture the thick shells that inclose powerful steam turbines. It weighs 115 tons. An idea of its enormous size may be gained by comparison with the workman standing alongside it. The piece to be bored is clamped to the base plate, and the boring tool, mounted on a rod whose maximum length is forty-six feet, is thrust forward into it as the machine advances along its geared track.

The giant boring machine. Compare its size with that of the workman at the right of the illustration

Sounds That Kill

DEADLY sound waves, of such high frequency that they are inaudible, recently have been produced by Prof. R. W. Wood, of Johns Hopkins University, and A. L. Loomis, in the latter's laboratory at Tuxedo Park, N. Y., using a quartz sheet vibrated 500,000 times a second by electricity. The experimenters found that when these waves were generated in a tank of water containing a number of small fish, the fish were mysteriously killed, their muscles reduced to a pulp.

In further studies reported to the National Academy of Sciences, the scientists discovered that blood corpuscles in salt water are broken down by the strange vibrations, and the whole fluid is tinged a clear red—unless a trace of gelatin is added. Artificial ice, compressed and placed in contact with the waves, is shattered into small crystals.

Oil, paraffin, and mercury, considered impossible to mix with water, combine with it under the silent sound waves to form semi-opaque mixtures. Thus, when a paraffin candle was suspended in the water the wax melted from the surface to form a "paraffin milk" that resembled real milk. Drops of mercury in the bottom of a vessel were split into globules so small that they could just be distinguished with a powerful microscope in the inky mixture they formed with the water.

The new waves Prof. Wood foresees may find future useful application in mixing hitherto antagonistic substances.

Light Signals Auto Speed

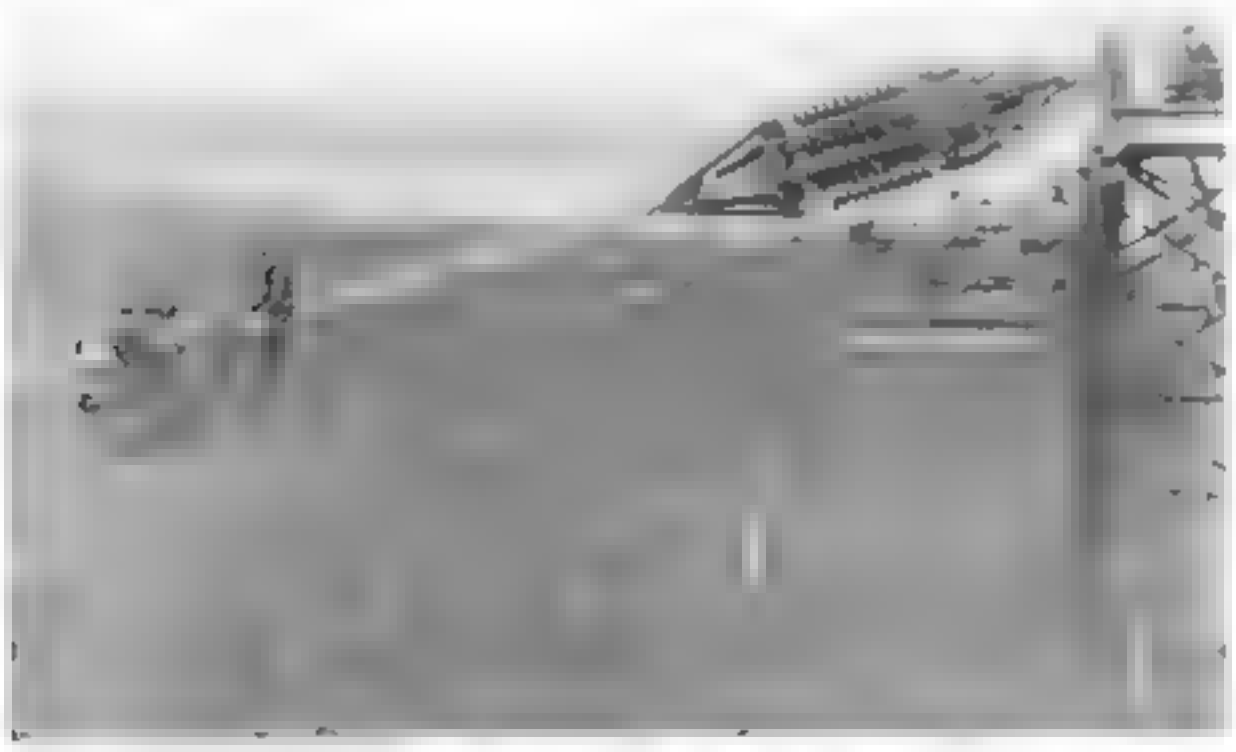
"IT'S folly to have a red light on the rear of an automobile without a similar warning at the front of the car." Voicing this belief, Samuel Storowitz, noted German engineer, has just invented a radiator cap light to warn pedestrians at night of the speed at which a car is approaching.

The contrivance consists of several lights of various colors arranged as a radiator ornament. For each ten-mile increase in speed, from ten to sixty miles an hour, a different light flashes. At sixty miles an hour a red light glows as a warning signal. It has been proposed that the red light should be made to glow as soon as the driver exceeds the legal speed limit, and that all motorists in Germany should be compelled to install the signal device.

Dark Rubber Lives Longer

FOR rubber articles that are likely to be exposed to sunlight, rubber of the darkest color will stay "alive" the longest. Recent experiments in the rubber laboratory of the U. S. Bureau of Standards have demonstrated that the shade of rubber goods has much to do with their durability.

In the experiments three samples of rubber, one uncolored, one black, and one red, were exposed to sunlight for six months. Tests of the samples were made at intervals, and revealed that the uncolored piece lost its life about two times as fast as the black one, but only about twice as fast as the red colored one.



Almost as thrilling as walking a tight rope. Here the cable painter is starting on the mile long journey high above Puget Sound. The paint is applied automatically

Ingenious Device Tests Air Pilot's Vision

HOW keen is a pilot's eyesight? This latest test for would-be aviators is a unique means for determining their ability to judge comparative distances. Two vertical bars, one fixed and the other sliding, are mounted on a platform against a white background.

Standing across the room, the candidate for a pilot's license aligns the movable bar by a string until he guesses it to be at exactly the same distance from the background as the stationary bar. A scale immediately shows how accurate his judgment was. Tests of this sort are important, for inability to judge distance may cause a pilot to wreck his plane when he makes a landing.

The new testing device is the invention of John Groves, of the Aeronautics Division, United States Department of Commerce.

At the right: Dr. G. Brent Dalton and Dr. M. A. [illegible] of the Carnegie Institution [illegible] Heaviside Layer

To Hush Riveters

EXPERIMENTS recently began by the U. S. Bureau of Standards may silence forever the deafening clatter of the pneumatic riveting hammers used in sky-scraper building and responsible for countless nervous breakdowns. The Government has set aside $100,000 for this investigation and the Bureau is conducting tests on the new National Press Club Building being erected in Washington, D. C.

A girder manufacturer of Washington recently loaned the Bureau his ten million pound compression testing machine for experiment, and the scientists are said to have put a successful silencer on it in the hope that this in some modified form may lead to silent riveting.

Drill Carries Its Own Motor

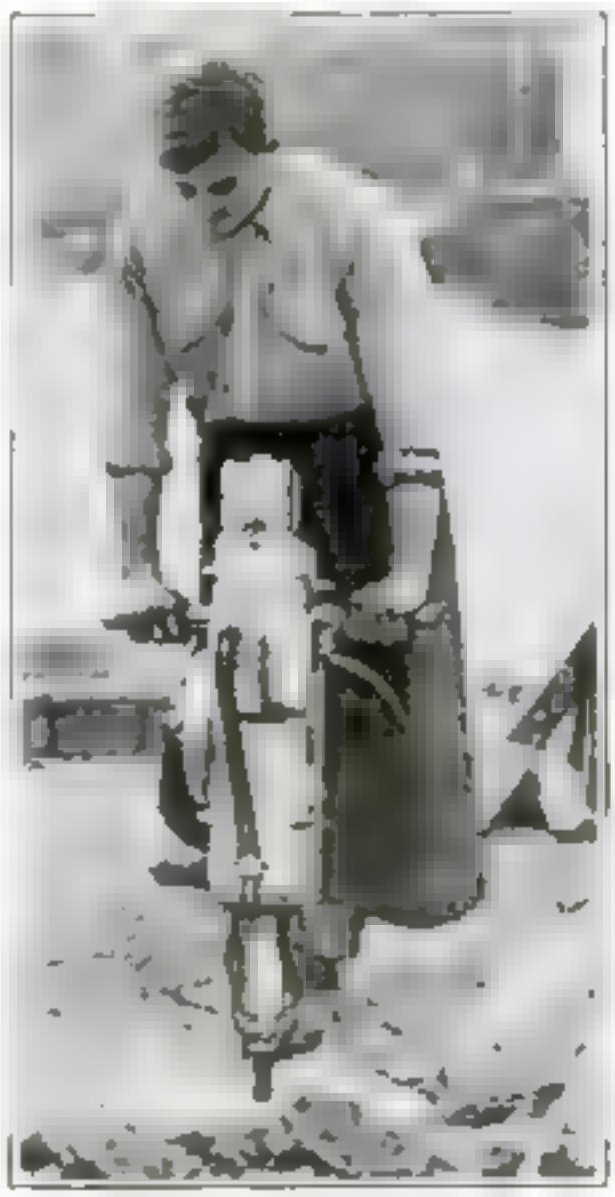
THE latest in rock drills is a new French invention that carries its own gasoline motor. It requires no compressed air hose to become tangled or to drag about when the machine is moved from place to place; the entire apparatus is self-contained. In spite of its bulk it weighs only seventy pounds.

A magneto furnishes batteryless ignition for the motor's single cylinder. Such a device is of especial utility in a quarry or mine where holes must be drilled in isolated places at some distance from the central source of power.

Hides Antenna in Ship's Hull

WHEN Capt. F. G. Moe, skipper of the recently completed thirty-eight-foot cruiser *Momo*, of New York, decided to install a radio set on the craft, he evolved a unique scheme to avoid unsightly antenna wires. During the building of the boat, he strung a single strand of insulated wire clear around the inside of the boat's hull to form an open loop. When the joiner work on the ship was finished, the antenna was completely hidden from sight.

Both ends of the loop are brought to a convenient plug where a radio receiver may be attached. The set is said to work perfectly on this unusual "aerial" and to receive signals equally well from both local and distant stations.



This newly invented rock drill contains a one-cylinder gasoline motor that drives it

"Radio Ironclad" 100 Miles Up

[illegible] of present experiments.

Tests [illegible] conducted will elaborate [illegible] concepts to measure its height and it is said that the average distance of the theoretical "Heaviside layer" from the earth is 100 [illegible]

a height of fifty miles are again cross-hatched. To these following courses of level flights alternate "finding" which has been one of the most invisible forms of trouble in radio transmission.

Glider Soars Fourteen Hours

IN A soaring flight of fourteen hours and eight minutes, Ferdinand Schulz, at Fussitten, Germany, recently achieved a new world's glider record. His success in keeping his one-seater, motorless craft off the ground far eclipses the previous record of ten hours and twenty minutes held by the Frenchman Maneaux.

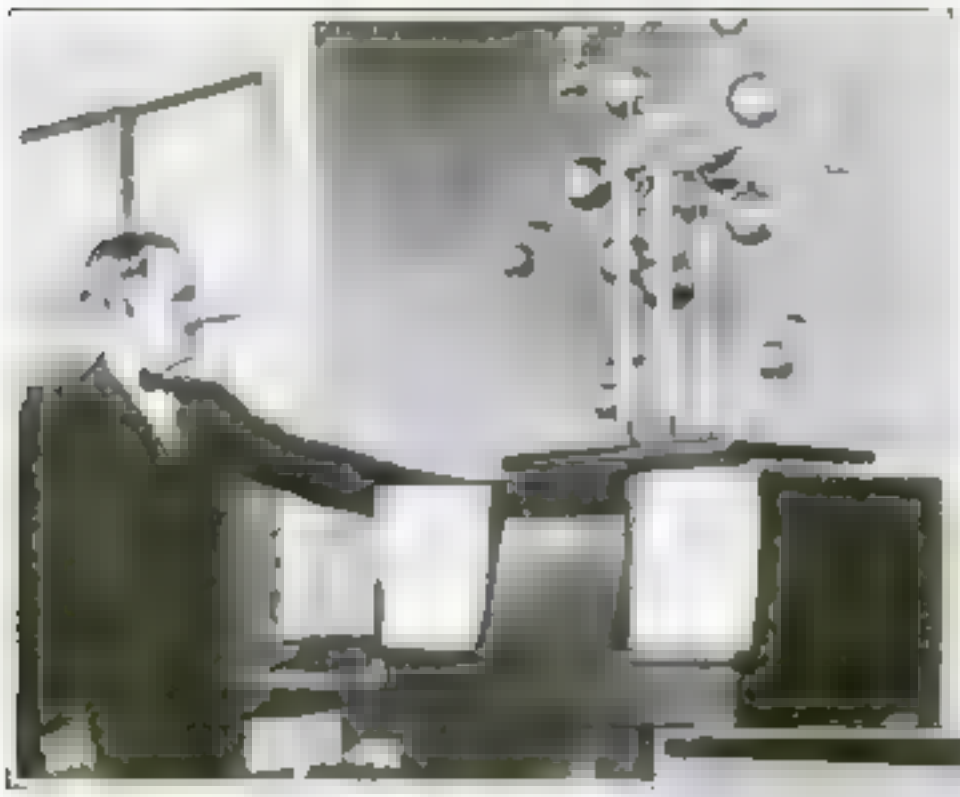
The Speed Limit of Vision

TWO scientists, Dr. F. W. Cobb and F. K. Moss, have measured the eye's speed limit. Your eye moves on a skip-stop system as it sees or reads, they say. After thousands of tests on eleven subjects, they found that to distinguish an object the average eye must stand still for about one seventh of a second. No amount of added illumination will speed it up. Most homes and factories are not brightly enough lighted to have reached the limit that these tests showed.

New Paint Stops Oil Leaks

A RED protective paint which is said to be the only known material that seals joints against oil leakage recently has been developed by the General Electric Company, Schenectady, N. Y. One of its first practical applications is in the manufacture of fuel oil burners, where it is applied to seal oil joints.

The paint can be applied either by brushing or dipping. It is said to dry rapidly and to produce a hard, glossy finish which can be cleaned easily. Denatured alcohol is used as a thinner.



"Perpetual Motion"—Almost

AT LAST a practical use has been found for a "perpetual motion" machine. Though, scientists agree, the original goal of a contraption that would work without outside power is impossible, all rights to such a "perpetual motion" device discovered by a Swedish and a German inventor, similar to earlier attempts, have just been purchased by an American manufacturers of ball bearings. They are exploiting the odd device as a new means of keeping their machines free from the inevitable enemy of all perpetual motion, friction.

The machine was displayed recently at the Massachusetts Institute of Technology. It consists of a wheel with a number of spokes, each holding a weighted ball at its end. In addition, the wheel is actuated by weighted rods that change their position constantly after the wheel is set in motion, driving it for hours before it eventually slows to a stop.

Measuring Niagara's Power

NEW measurements of Niagara's power by Government engineers will show how much loss of electric power can be blamed on the sinking level of the Great Lakes, by determining the quantity of water now flowing over the American side of the falls. With the aid of the Coast Guard station at Niagara Falls, N. Y., they recently shot a line across the American falls at the head of Goat Island, and attached a cable by which they could measure the river's depth and speed. Allowing for the fraction diverted for electric power, this will show the volume of water flowing over the falls, and will be compared with the old figure of 8000 cubic feet a second.

Twins' Minds Run Alike

JUST as they resemble each other physically, twins are alike mentally. This is the conclusion drawn from recent experiments at Columbia University, in which mental tests were given to 136 pairs of twins. Those of the same sex were found to differ less than boy-girl twins; and the ones that looked most alike had the closest mental ratings.

Model Stage Tests Lights

PROBLEMS of producing striking stage lighting effects are easily worked out with the aid of an ingenious working model invented by George L. Hall of Melrose, Mass. He has built a model stage, complete with tiny flood and spotlights. Working a small-size electric control panel, a stage electrician can use the model stage to plan in advance how his lights shall be operated.

Largest Oil Burning Ship to Have No Funnels

SO RAPIDLY has the motor ship attained favor that sixty percent of all the ships now under construction in the United States, and half of those in the world, will be powered with oil-burning motors instead of the former coal-fired steam boilers.

In Italy a motor ship, the *Saturnia*, is being built which will overshadow even the 683-foot *Asturias*, at present the largest motor ship afloat. The new vessel will have accommodations for 3000 passengers and deck space for airplanes. Funnels will be lacking.

Most of the present motor ships, including the *Asturias*, carry funnels. They are a concession to the fact that people are not yet accustomed to seeing a ship without funnels.

Building Mammoth Generator

A NEW power station under construction on Lake Michigan near the Indiana-Illinois state line will have a steam turbine generator more nearly three times as large as any of the giants now in service. It will be rated at 208,000 kilowatts, or two thirds the capacity of the Niagara Falls hydro-electric generating station.

The complete weight of the machine will be 4,000,000 pounds, and of its heaviest single part, 275,000 pounds.

Warns of Dangerous Fumes

WITH the increasing use of hot mercury in industry, in chemical processes and in the new mercury turbine, the presence of poisonous mercury vapor in the air has recently become a menace to workers. Now a device has been invented that automatically gives an alarm when even one part of mercury in twenty million of air is detected.

A transparent strip of paper, coated with a chemical that darkens in the presence of mercury, ordinarily permits light from an electric lamp to fall on a light-sensitive electric cell. But when the paper blackens, giving a telltale warning of the deadly vapor, the light is cut off and the electric cell gives the alarm by ringing a gong.

"Touchy" Electric Cable Traps the Burglar

A SENSITIVE electric cable that responds to the slightest touch is the latest idea in burglar alarms, invented by a German engineer. It looks innocent enough, but step on it anywhere, or even touch it lightly, and an alarm bell rings.

Along the entire length of the cable run two electric wires, and pressure at any point makes contact between them to close the circuit and give the alarm. In the photo the inventor is showing how a slight pressure on the cable causes a lamp to light.

The inventor of the new burglar alarm demonstrates how the slightest touch of the cable will light a small battery lamp

Factory Ventilation Studied with Model

BY MEANS of an ingenious working model, New York State's Department of Labor can demonstrate graphically the need of special ventilation for factories where manufacturing processes result in acrid, injurious chemical fumes.

A small replica of a large-scale ventilating installation, the model uses a fan blower run by an electric motor to suck noxious fumes through inverted funnels into pipes to the roof. A hot plate warms small cauldrons, and the escape of their fumes is studied.

At the left, Dr. L. F. Cutler of the division of industrial hygiene is showing how the model works.

X-Rays Ferret Out Rum

HUNTING bootleg liquor is the X-ray's latest use. With a special apparatus recently constructed for George Contreras, Chief Prohibition Agent of Los Angeles County, Calif., by R. H. Milligan, X-ray expert, searchers for liquor will soon feel at home when examining cases of it disguised as cakes of hay in a hay-carrying motor truck.

The photographer who accompanied them on their raid snapped the photograph at the right just as the discovery was made. At the right of the truck is the portable apparatus used to generate the rays. The man standing behind the truck has just perceived the telltale outline of bottles on the screen of the fluoroscope he is holding in his hand.

The Hottest Spots on Earth

WHILE you are fanning yourself this summer, perhaps you may find solace in the fact that there are other places in the world far hotter. The world's hottest spot, according to the records, is Azizia, in the semidesert plain of Jefara, northern Africa. There the thermometer rose to 136.4 degrees in the shade on September 13, 1922. The average yearly temperature for the region is 70.8 degrees. Previously the high record had gone to Greenland Ranch on the edge of Death Valley, California, where the thermometer once reached 134 in the shade, and where it goes higher than 120 degrees every summer.

The earth's coldest spot is Verkhoyansk, Siberia, just within the Arctic Circle, which experienced 90.4 degrees below zero in January, 1885. Unofficially it was reported that this record was broken there last winter with 97.6 degrees below. This place, however, is warmed during its two-month summer by temperatures that rise to 80 degrees.

The low record for the United States—65 degrees below—is held by Miles City, in the eastern part of Montana.

AQUARIUM OWNERS whose goldfish seem ailing are promised a remedy by Ida M. Mellen of the New York Aquarium. While treating goldfish, she discovered that a kerosene bath and a bath in a solution of aluminum sulphate restored health.

Strange New Liquid Makes Wood Fireproof

A REMARKABLE liquid which when used to impregnate wood makes the wood fireproof, has been perfected by a Finnish inventor according to reports to the U. S. Department of Commerce.

In recent tests of the invention a small housing was constructed of wood that had been treated by the solution. Although the building was saturated with oil, every attempt to ignite it failed.

The liquid, it is said, costs so little that it can be used in the cheapest sort of construction. Wall paper coated with it also is protected from fire.

A Deep-Sea "Butterfly Net"

TO CAPTURE tiny creatures which live on the bottom of the sea and which are likely to escape a dredge or trawl, Dr. O. P. J. Mortensen, a Danish naturalist, has invented an ingenious device that is a very "considerate" catcher. It is a metal sled with runners and a fine silk net stretched on top.

The sled is let down at the end of a cable, then hauled along the bottom of the sea. As the runners skee over the mud, myriads of small creatures living there, like insects in a field, are trapped in the silk net, to be hauled to the surface for study.

Tin Not Harmful

THAT the tin used as a lining for most cans contains long food has no effect on the human body is the recent conclusion of Doctors E. W. Swanzie and W. F. Clarke, chemists of the U. S. Department of Agriculture.

In experiments with asparagus and pineapple, foods which might be expected to set up chemical action in combination with the tin lining, they found not the slightest unfavorable effect. Moreover, after feeding tin to human beings in two-gram doses, they could find no evidence that it had been absorbed by the body.

Tests a Tippler's Breath

A DRINKING man doesn't stand a chance these days. Now a device has been invented by W. D. McNally, coroner's chemist of Chicago, Ill., that is said to tell infallibly whether a person has taken a single drink. When he breathes through a glass tube into the simple apparatus shown in the photograph, specially prepared chemicals in the bottles change color if there is the faintest trace of alcohol. By this means, the inventor suggests, police might test auto drivers suspected of drunken driving; or, as suggested in the picture, doubtful wives might test their errant husbands before admitting them late in the evening.

Chemicals in the bottles change to a slightly greenish color if a trace of liquor is on his breath

AMERICANS HOLD 70,000,000 phone talks a day, on 17,000,000 telephones. To transmit these messages, there are 43,000,000 miles of wire.

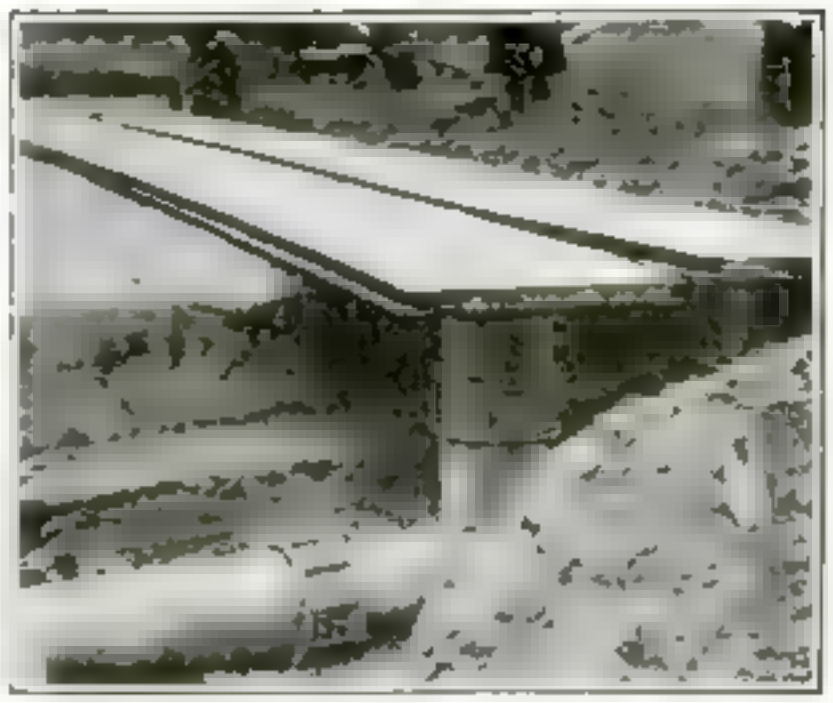
Valuable New Mineral Found in Vast Deposit

NONBREAKABLE glass for baking dishes, bottles, pitchers and the like soon may be available in greater quantities and at lower prices than ever before, through the recent discovery, in Kern County, California, of about eight million tons of an entirely new mineral. This mineral, called "rasorite" after its discoverer, C. M. Rasor, a borax engineer of the Mohave desert field, is known to chemists as the tetrahydrate of borax. It was found in large crystal-like bars resembling glass in texture. A comparatively simple and inexpensive process converts these bars into commercial borax, which is used extensively for enamels, welding fluxes, laundry materials, and in the manufacturing of the almost unbreakable borosilicate glass.

Since other important borax ores require expensive chemical processes, the discovery of the new supply is expected to reduce greatly the price of the product. The find is one of the most remarkable in the history of mineralogy.

Space-Saving Gas Mains Shaped Like Planks

WITH only one foot of room between the surface of Central Parkway, in Cincinnati, O., and a new subway beneath, city officials asked themselves how sixteen-inch gas mains were to cross the street. The problem was recently solved by a novel expedient. Special flat pipes, only a few inches thick, were constructed of riveted steel, and laid above the subway roof, leaving several inches to spare. At each end the regular sixteen-inch mains were connected, as shown in the photograph.



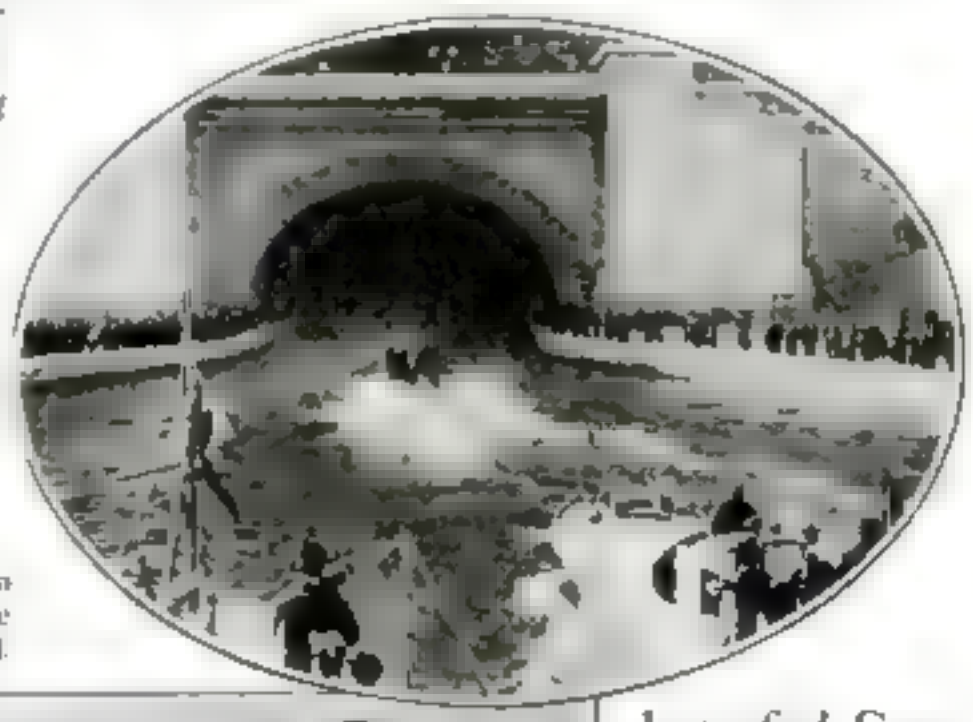
RADIUM CAN be employed to remove superfluous hair, according to Hayward Pinch of the Radium Institute in London. The rays, which kill germs and cancer cells, also destroy hair cells buried in the skin

Canal Runs through Five-Mile Tunnel

WHEN French engineers set out to connect the coast port of Marseilles with the inland city of Berre, about fifteen miles away, by waterway, they found a seemingly insuperable obstacle in their way—a high intervening ridge of mountains. After fifteen years of work they have at last completed one of the most remarkable canals in the world. It travels for more than five miles underground.

The subterranean tunnel is seventy-two feet wide and cost sixty million dollars to build. It connects the coast, via the small under the mountains, with Lake of Berre.

The photograph below shows the first boats entering one portal of the tunnel during recent dedication ceremonies.



The liquefied natural gas is supplied to homes in the drums seen at the left. When empty, they are returned to the factory and refilled

Liquefied Gas for Fuel

NATURAL gasoline, a valuable domestic fuel, is now obtained in the Middle West from extinct oil wells in a new process made possible by an improved machinery.

Long after it has ceased to be worthwhile to pump oil to the surface from a well that has nearly run dry, large quantities of extremely rich natural gas continue to rise through the abandoned oil or fuel. This gas, compressed to a liquid and "bottled," is said to be an excellent substitute for gasoline or oil.

Why Your Watch Slows Down

WHAT makes your watch run slower in summer than in winter? Dr. P. G. Nutting, physicist of the U. S. Geological Survey, who has just completed a study of this mystery, reports that the change is due to moisture in the air, and not, as many people suppose, to differences in temperature.

Most watches are kept reasonably warm, even in winter, he points out. The real reason why watches speed up a little in winter and slow down in summer is the condensation of a film of water on the balance wheel during warm weather, when the air is much more moist. This film is too thin to be seen even with a microscope, yet it adds enough extra weight to the wheel to make it run a trifle slower. At the seashore where the air is especially moist the slowing-down effect is most noticeable. In dry winter air the moisture vanishes and the watch speeds up.

New "Booster" for Airplanes

GREATER power for airplane engines at all altitudes, higher speed, and capacity for heavier loads, are promised through the use of a new built-in supercharger developed at the research laboratories of the General Electric Company at Lynn, Mass. Heretofore the superchargers used with engines of Army and Navy airplanes have been separate attachments. Now they can be made an integral part of commercial airplane motors, merely by the addition of two gears and a mechanism known as an "impeller."

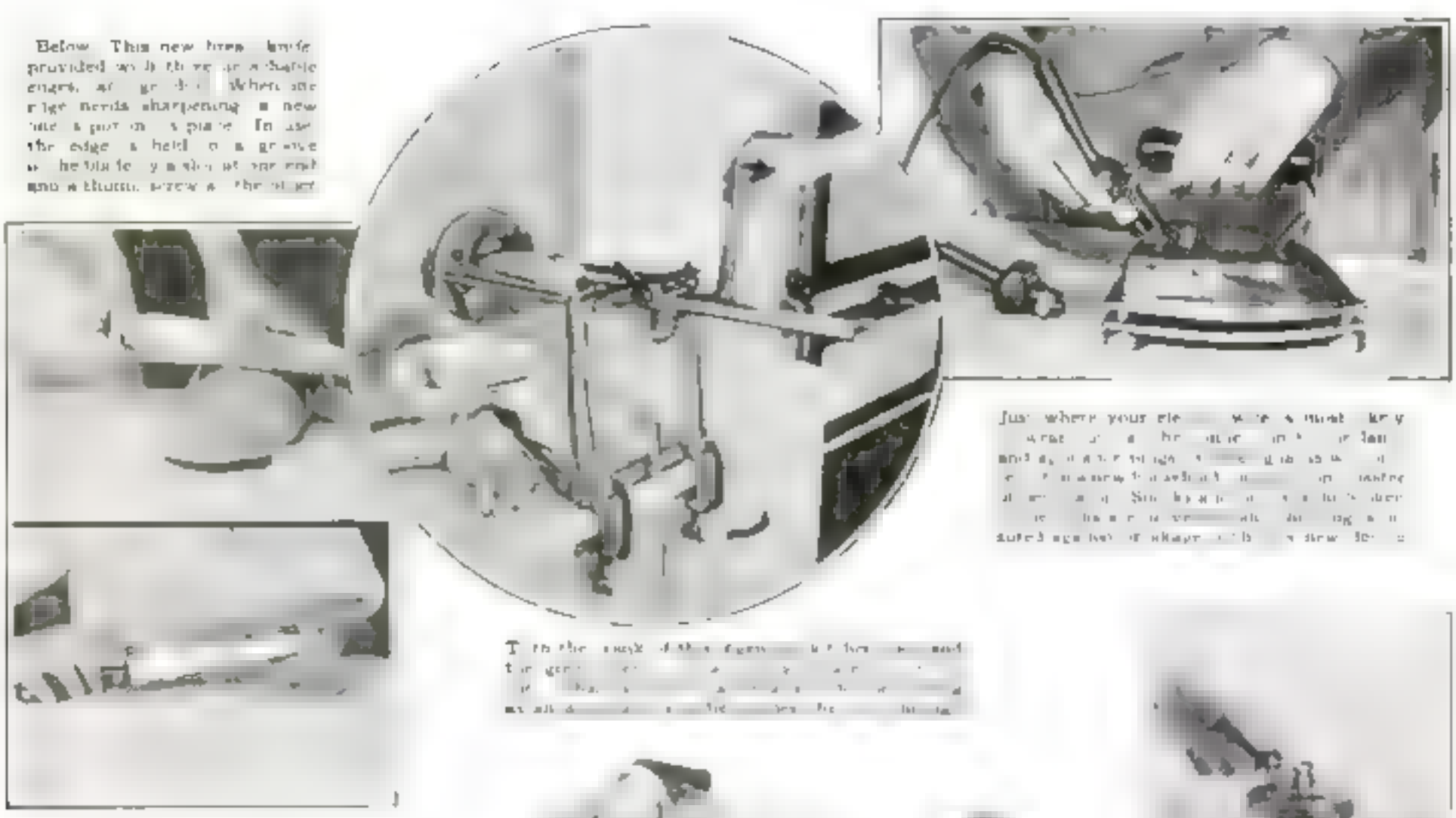
"The supercharger does for the airplane what the oxygen tank does for the pilot when flying at high altitudes," explains Dr. S. A. Moss, designer of the new supercharger. "It prevents suffocation."

Plaster Statues Made Bronze

PLASTER statues are turned into metal ones by an ingenious "extrusion pistol," devised by a German artist-inventor. It shoots a fine stream of melted bronze against the inside surface of a hollow plaster cast with such force that it passes through the plaster and forms a thin film on the outer surface.

Novel Mechanical Devices

Below: This new type knife provided with [illegible] edges, [illegible] When one edge needs sharpening a new one is put on [illegible] In use the edge is held in a groove [illegible] by a screw at one end and a thumb screw at the other

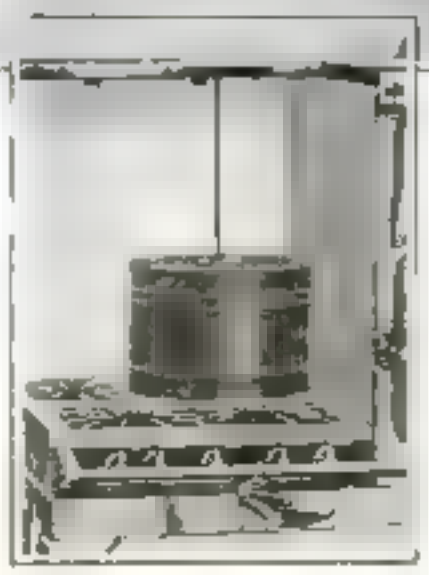


Just where your ele[illegible] a metal key [illegible]

To the end of this [illegible]

[illegible] Pyrex [illegible] engineering [illegible] does not [illegible] the [illegible] glass [illegible] Asbestos [illegible] the [illegible]

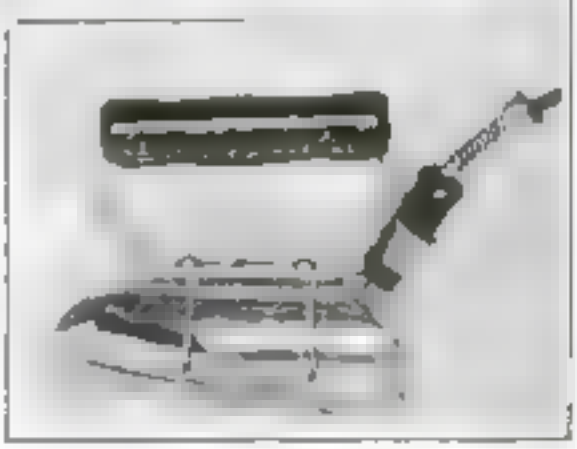
Asbestos protectors attached with screws serve as rests for pots when not in use and protect the burners when in use. A rail prevents pots sliding off

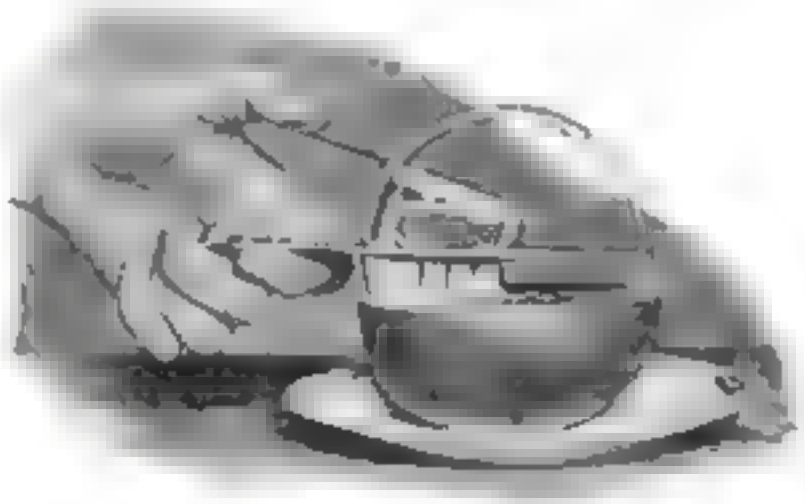


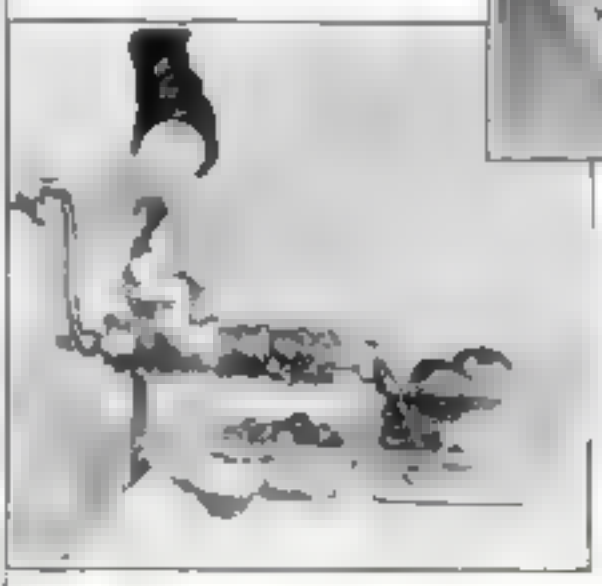
This gas range [illegible] the heat [illegible] suspend the [illegible] however [illegible] and retained heat [illegible] danger [illegible]

A [illegible] Device [illegible] A long handle [illegible] and a spring [illegible] as the handle [illegible]

Make Housekeeping Easy







Manless Tractor Plows without Steering

BEFORE a group of agricultural experts and practical farmers gathered recently at the College of Agriculture farm of the University of Nebraska, a remarkable tractor that ran by itself successfully plowed a twenty-acre field. It was the invention of F. L. Zibach, a Grand Island, Neb., farmer, who devised for it an automatic guide which allows it to run without a man steering it.

The guide is a curved piece of metal hinged on the front of the tractor, that guides along the furrow last plowed and keeps the steering wheels aligned against its edge by means of a powerful spring. Wherever the furrow leads, the tractor follows, plowing another furrow just inside it.

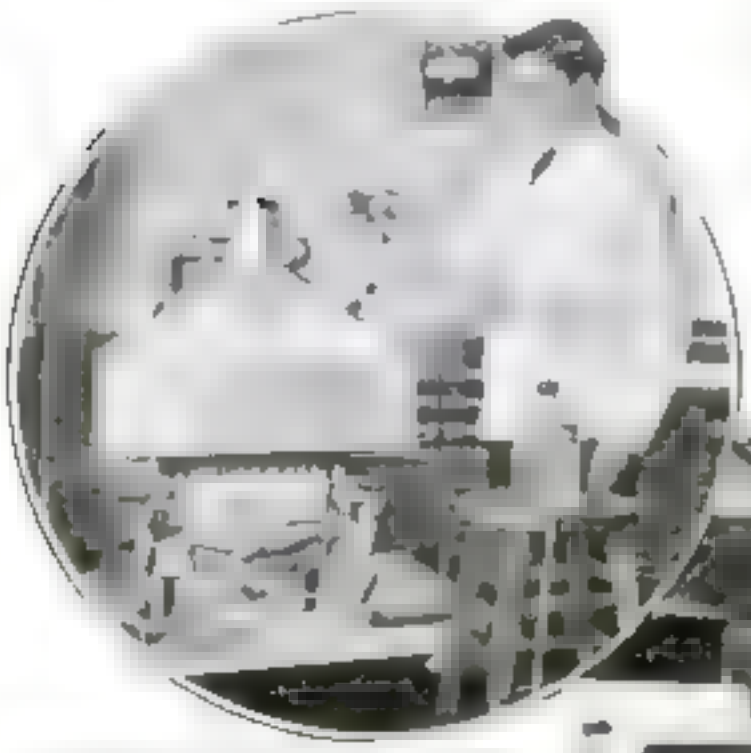
Thus, when Zibach sets out to plow a field of any size whatever, he guides his tractor once around the outside border, coming to rest with one of the tractor wheels in the furrow he has just plowed. Then he lowers into place the automatic guide, turns on the "gas" and goes away! Without a human hand to guide it, the chugging machine circles the field in a spiral, or a rounded square, of constantly dwindling diameter, conscientiously plowing every square foot of ground.

In case the machine "jumps the track," or the plow hits an obstruction, Zibach says, an electric switch on the front axle automatically cuts off the ignition and stops the tractor. Otherwise the only attention it requires is to be replenished with gasoline, oil and water about twice a day.

This guide, projecting like a "feeler" from one front wheel, holds the tractor along the edge of the furrow which was last plowed

The automatic tractor plow. Running unattended from sunset to sunrise, it plowed a large section of land while the farmer slept

Gas Appliances Made Safer by Laboratory Tests



Checking washing tests in Fahrenheit in tween-the-stage chambers in the laboratory

[illegible] gas range [illegible] Washington [illegible] Institute [illegible] monoxide [illegible] Home and other gas [illegible] observed in the American Gas Association's laboratory at Cleveland. [illegible] are performed on [illegible] of household gas appliances.

Three pipes of different colors supply the laboratory with water gas, coke-oven gas, and natural gas, to duplicate the supply anywhere. A certain cooking range might work well in Baltimore but [illegible] and [illegible] Los Angeles. [illegible] [illegible] of gas used makes a difference.

In determining [illegible] a range to burn, [illegible] a wall [illegible] with thermometers and run. Observers check the temperature at surrounding points, to make sure that it is below the danger limit. The test for dangerous carbon monoxide gas is so delicate that the electric recording device, developed by the U. S. Bureau of Mines, detects even traces in the smoke belched by locomotives on the railroad track near the laboratory, it is sensitive to two parts in 100,000. Samples are taken of the air above gas range burners and near radiant heaters by a domelike hood.

A good heater, the tests have revealed, generates less carbon monoxide than three men smoking cigars in an average room!

In all, 160 different tests are made on a gas range. A procession of ranges travels around the room, like a line of automobiles on a factory conveyor, and ten different tests progress simultaneously on as many ranges. Even a baking test is performed, for at one point a pan of crisp biscuits is whisked from the oven and examined.

Besides the electric carbon monoxide recorder, there is a chemical apparatus sensitive enough to measure its accuracy. How well a heater heats is measured by an extremely delicate thermopile designed by Dr. W. W. Coblentz, of the Bureau of Standards, similar to the type he uses for measuring the temperature of Mars.

More than 2300 types of gas ranges and eighty-five heaters have so far been tried out in this laboratory. Eventually tests will be made of every known make.

Taking biscuits from oven after baking experiment, one of the 160 different tests made on gas ranges

Hints for Radio Beginners

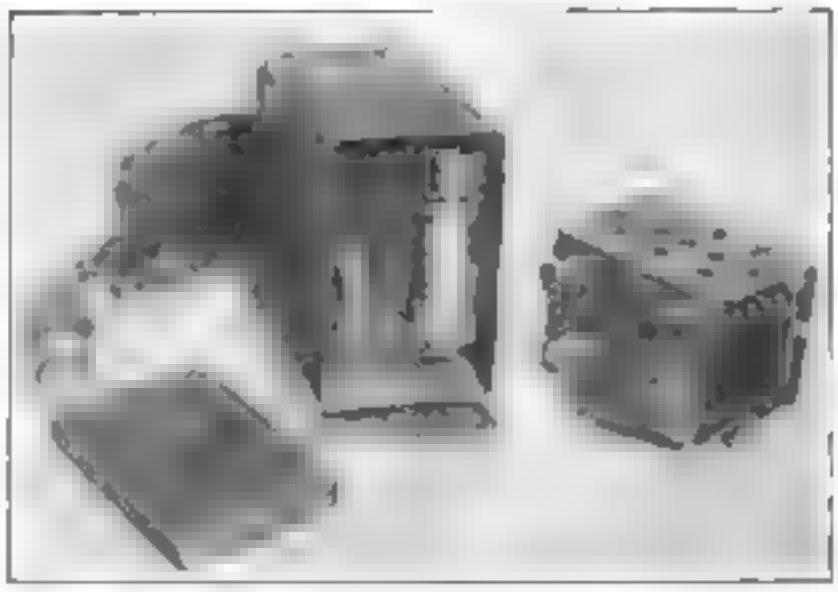
New Ideas for Chargers

How to Get Better Service from Dry Cells and Tubes

RESEARCH engineers are constantly working on the problem of improving radio battery chargers. Two novel developments, recently announced, are shown in the illustration at the right. One is a new type of A-battery charger containing no tubes nor liquid cells and which is remarkably compact. It gives a two-ampere charging rate and consequently is not suitable for trickle charging, but is surprisingly efficient. Although it takes but twenty-five watts of current from the light socket, thirteen watts of current are delivered to the battery, which means that the charger is slightly more than fifty percent efficient, a very high figure. This charger is shown at the left in the picture. It consists of a small alternating current transformer mounted in a case with clips at one end to take an ordinary automobile-type fuse and a rectifier cell. The makers of the rectifier cell claim it will last at least 1,000 hours. At the end of that time it can be replaced with a new rectifier cell as easily as replacing a cartridge-type fuse in an electric switchboard.

A full-rate charger of this type can be used in the conventional arrangement with an automatic relay to turn it on and off, as with the various types of trickle chargers. The difference is that you will have to remember to keep the charger turned off more than half the time.

At the right in the illustration is a new unit to replace the electrolytic rectifier cell in any standard type of trickle charger. Like the full-rate charger, it is perfectly dry and has no adjustments. It is a result of the discovery that copper crystallized in a certain way can be connected in a circuit so that it will pass current only in one direction. The internal arrangement of the unit is such that it gives full wave rectification and consequently a slightly higher charging rate than the electrolytic cell.



At the left is a new type of two-ampere charger that uses a dry tubular rectifier. The "dry" replacement unit at the right can be used instead of the liquid rectifier cell

Static Still Unconquered

WHILE governments and individuals are still striving to find out just what causes static, and many remarkable facts have been recorded concerning it, radio fans still are at the mercy of this noisy nuisance. It is generally admitted now that thunderstorms have much to do with the production of static, and thus the quantity of static is being used as an indication of approaching storms. By reference to previous measurements of static intensity, it is possible, even, to predict with considerable accuracy the severity of the approaching storm.

Dr L. W. Austin, in charge of the radio transmission laboratory of the Bureau of Standards in Washington, states that as far as overcoming the effect of static is concerned, experimenters are still at sea, although every day more and more is being learned about it

A B C's of Radio

THE beginner in radio construction is inclined to rush things. Naturally you are eager to get the set in operation, but it will pay in the end to make haste slowly.

In assembling a set, the first step, before you get out drill and soldering iron, is to make sure you have every part on hand. Don't figure you can get part of the work done, and then buy the rest of the parts. You are sure to run into trouble. The space you have allowed for the new parts may not be sufficient, or the parts may not fit in with what you already have accomplished.

And remember to fit the panel to the cabinet and complete the supporting structure before you begin to mount the various instruments.

Sandpaper the prongs of your radio tubes every few months to insure quiet operation

Keep Tube Prongs Clean

SANDPAPERING the tube prongs with a fine grade of sandpaper every few months is a wise precaution to prevent trouble from contacts. In any electrical circuit, the effect of a poor contact depends largely on the voltage of the circuit. The lower the voltage, the more important it is that the contact be as nearly perfect as possible. In your radio set, the filament circuit that carries the current to light the tubes is low in voltage, while the plate circuit is far higher. So it is most important to keep the filament supply prongs clean. The filament prongs on all modern tubes fitted with the X type base are the two thick ones.

Heat Spoils Dry Cells

MYSTERIOUS failures of dry cell A- and B-batteries often are due to keeping them where the summer sun shines on them for several hours each day. Under such conditions they reach a temperature much too high for best results. Dry cells are dry only outwardly. Inside there is considerable moisture, and the functioning of the cell depends on this moisture. Excessive heat seems to drive it out through the pores of the retaining material, and the useful life of the cell is shortened.

C-Voltage for Power Tubes

WHEN you purchase a new power tube you will find packed with it an instruction slip specifying the correct voltages for best results. Usually there is a table of C-battery voltages that are right for various B-voltages. You cannot accurately determine the voltage developed by any ordinary type of B-eliminator by means of a voltmeter, for the voltmeter itself draws so much current that the voltage reading will be far lower than is actually being applied to the radio set.

Under such conditions, the best you can do is to guess at correct C-battery voltage. This is not difficult. In any case the correct C-voltage is the highest voltage you can use without causing the music to get thin and reedy. Watch out that you do not operate the power tube at too low a C-voltage. The tone quality may sound all right, but the tube will be overloaded and its life will be materially shortened.

How to Hook Your Phonograph to the *Radio Set*

Pick-Up Device Gives Old Machine a New Voice

By ALFRED P. LANE

HAVE you ever wanted to get dance music on your radio and found that not a single station was broadcasting it at that particular time? Or have you ever desired a few bars of soothing instrumental music to put you in the proper frame of mind for a sound night's sleep only to find that all the stations were burning the air with red-hot jazz?

Instead of turning off the radio in disgust on such occasions, why not fix things so that when the broadcasting stations don't give you what you want you can manufacture it yourself?

The new method of transferring music to phonograph records, together with the development of apparatus that will transform this record into exactly equivalent electrical vibrations, has made this feat possible.

Radio has made such a hit because the music and speech are natural and lifelike. In fact, the marvelous tone quality of really good radio reproduction nearly wrecked the phonograph business. Phonographs had been made year after year with no improvement in tone quality. The public appeared to be satisfied and so were the manufacturers. Then along came radio and the phonograph makers woke up one morning to find that their business was "shot to pieces." They had to do something or else close up shop and, assisted by the developments in the new art of radio, combined with intensive research work, they revolutionized the whole method of recording and reproducing records.

IN TONE quality, the phonograph now is on a par with the finest radio set. The wavering groove in the modern phonograph record is an almost perfect picture of the music it is supposed to represent.

Of course, the simplest way to reproduce these perfect records is to buy an up-to-date phonograph, but that expense is not necessary if you possess a high grade radio receiver and an old phonograph. The condition of the phonograph is quite immaterial so long as the motor still is capable of turning the record at a uniform rate. And even if your radio set is somewhat antiquated it will be cheaper to rebuild it to modern standards than to purchase one of the new type phonographs.

A vital factor in securing high class reproduction of phonograph records by

Fig. 1. If your radio receiver is a late model or has recently been brought up to date you can use the audio amplifier in it to reproduce the marvelous new phonograph records by using a pick up device connected up to your old phonograph

way of your radio set is the pick-up device. This instrument, of which several types have been approved by the Popular Science Institute of Standards, consists of a tiny electrical unit inside of a metal case. Protruding from the lower side of the case is a standard type of socket for the usual steel phonograph needle. The needle, of course, rides in the groove in the phonograph record and serves to translate the wavy irregularities in the groove into mechanical vibrations that are in turn converted into equivalent electrical oscillations by the pick-up device. These electrical oscillations are about as strong as those produced by the detector tube in your radio set when you are receiving a strong local station. In fact it is possible to connect up a pair of headphones direct to the device and enjoy the music without the aid of any batteries or audio amplification.

TO AMPLIFY the music as produced by the pick-up device you use only that part of the electrical circuit in your radio receiver that follows the detector tube. Therefore it makes no difference how efficient your set is in bringing in distant stations or in choosing between them. All that counts is the audio amplifier. That must be modern in every respect if you want really good tone quality.

Assuming that your radio receiver is of a late model or the audio amplifier in it already has been brought up to date, the problem of connecting up to the device that takes the place of the ordinary tone arm and sound box on your old phonograph is extremely simple. A complete arrangement of this type is shown in Fig. 1. At the left is a small portable type phonograph which for this particular use is just as good as a high priced cabinet machine except, of course, that it needs winding more often.

The tone arm of the phonograph has been moved over to one side out of the way and the electrical pick-up device has been placed in position so that it will properly track in the record groove. In all of these pick-up devices, the current is fed to the audio amplifier through a volume control which, ordinarily, is merely a variable resistance connected in a potentiometer circuit.

From the volume control box you will note that a cord leads to a plug that is inserted in the detector socket of the radio set in place of the detector tube.

Different makes of pick-up devices use different forms of attachments to con-

Coming Next Month!

BEGINNING in the September issue, a series of articles in the Home Workshop Department will describe in detail the construction of up-to-date B-battery eliminators, including circuits that are absolutely troubleproof on any type of radio set.

nect in place of the detector tube, but in any case the result is the same and if the detector tube were not in the circuit at all the circuit could be arranged as shown in Fig. 2, in which the two wires from the pick-up device are connected to the P and plus B binding posts of the first stage audio transformer.

With the outfit arranged as in Fig. 1, put a record on the phonograph, set the needle in the outer groove, turn on the radio set in the usual manner and set the record in motion. Adjust the volume to suit yourself by turning the volume control knob.

YOU will be impressed at once with the fact that the needle scratch ordinarily heard even on the best of modern phonographs is almost entirely absent. These needle scratching noises are very high in pitch and it has been found possible to get rid of them by the use of by-pass condensers without materially changing the nature of the musical reproduction. However, you need not worry about these by-pass condensers. They are built in as part of the pick-up device either in the electrical unit or in the base of the volume control unit.

While these condensers suppress the needle scratching noises in the electrical impulses as they are fed into the audio amplifier so that they cannot be heard from the loudspeaker, there are mechanical scratching noises that are sent out on the air directly from the needle itself and the metal parts of the pick-up device. You will not be bothered by these noises when you have the volume control set so that the music is loud but they will prove bothersome when the music is turned low. This is because the amount of scratch noise produced by the needle is a fixed quantity and consequently becomes louder in proportion when the volume of sound from the loudspeaker is reduced.

The way to get rid of this scratching noise is to muffle the electrical pick-up device by keeping the lid on the phonograph closed while the record is being played, and if you are extremely fussy on this point, you will find it worth while to line the inside of the top with felt and as a last refinement, plug up the mouth of the ordinary horn on the phonograph with old rags.

Perhaps you haven't any type of radio receiver. In that case you can get the finest of modern music from your old phonograph by building a special audio amplifier according to the arrangement shown in Fig. 2. Then if later on you want to get radio reception as well, you can build a simple radio set and use the audio amplifier you already have built for the phonograph.

This audio amplifier circuit has been amplified as much as possible without sacrificing tone quality. There are no adjustments of any kind. All you need do is build it from high grade parts, put the specified tubes in the sockets and after connecting up the batteries turn on the filament switch which is shown in the circuit just above the binding post marked minus A, then plug the phonograph pick-up device in one end and the loudspeaker in the other.

In building the amplifier you don't have to follow conventional radio practice and house the amplifier in a special radio cabinet with a composition front panel. If the instruments shown are arranged in approximately the positions given in the diagram, the box or compartment in which you house it can be of the smallest possible size, and if you want to fit the amplifier into a given space, considerable liberties can be taken with the arrangement of the instruments provided that you keep G-G, P P and F-F connections as short as possible. Modern types of audio amplifying transformers usually are not fitted with binding posts at the top as shown in the drawing. In most cases they are near the base of the instrument. They were drawn at the top to make the wiring as clear as possible so that the beginner will have no trouble in figuring out connections.

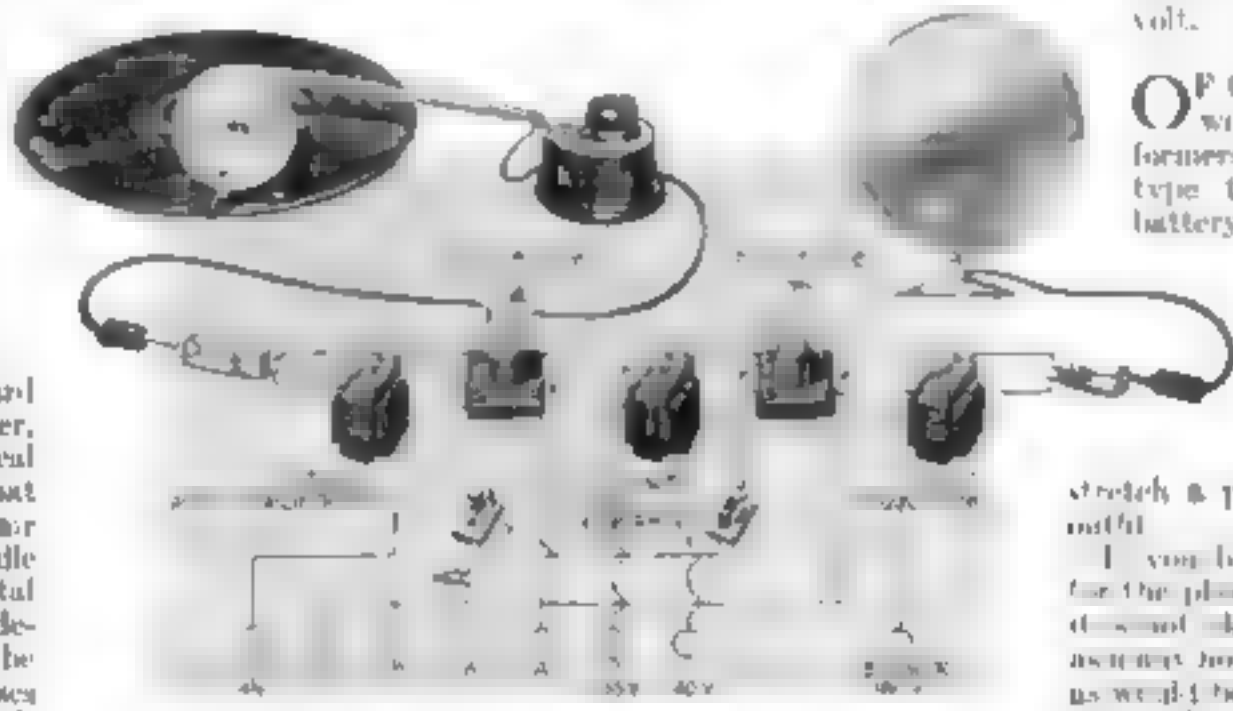


Fig. 2. Here is a hook up that will show you how to get perfect reproduction of the new phonograph records. You can assemble an audio amplifier according to this diagram or use it to help you modernize your radio receiver. Use only high grade parts

A complete list of the apparatus needed to build a modern audio amplifier as shown in Fig. 2 would read as follows.

Two audio transformers of the highest grade.

One output transformer also of the highest grade.

Two vacuum tube sockets.

Two self-adjusting rheostats size 112.

Two open circuit jacks or two pairs of phone binding posts.

One filament switch.

Eight binding posts.

For tubes you need one power tube of the 112 type and one of the 171 type, and of course you need a loudspeaker. Get a good one. You can't get good music out of a poor speaker.

The battery hook-up is really quite simple, and you can use a B-eliminator if you prefer. In any case connect a six-volt storage battery with the positive terminal to binding post plus A and the negative terminal to binding post minus A. Take four 45-volt blocks of dry cell B-battery and connect them in series, that is, with the plus terminal of one block connected to the minus terminal of the next and so on. Then connect the minus terminal of the first battery with the minus A binding post. The plus B 135-volt binding post should be connected to the plus end of the third block counting from the minus end and the plus B power 180-volt binding post is wired to the plus end of the four blocks of battery.

A 4½-volt C battery should be connected with the positive terminal of the battery to binding post marked C plus and the negative or minus end to the binding post minus 4½ C. An entirely separate medium size 45-volt B-battery should be used to get the necessary high C-voltage for the power tube. It should be connected with the plus terminal to the plus C binding post, which makes two wires connected at that point, and the minus terminal should be wired to the binding post minus C 40 volt.

OF COURSE this amplifier will work with cheap transformers and ordinary 201A type tubes and a total B-battery voltage of 90, but anyone who has listened to such an outfit compared with an amplifier using good parts and the power tubes certainly will stretch a point to get the better outfit.

If you build the amplifier only for the phonograph pick-up device it is not likely to be in use nearly as many hours a day on the average as would be a radio set. With the latter, there always is the temptation to tune-in a given station and let it run for the rest of the evening. This you cannot do with the phonograph because of the necessity of changing records. Consequently it is quite practical and economical to operate the entire amplifier on dry cells if you are willing to get along with somewhat lower volume than is obtainable from the storage battery operated amplifier.

THE construction is exactly the same for dry cell operation except that you use a 4V 109 size self-adjusting rheostat at X and a 120 size at Y. Substitute a 199-type tube for the 112 and a 120 type power tube for the 171. Use six No. 6 dry cells wired in two sets of three in parallel in place of the storage battery. Connect up three 45-volt dry cell B-batteries in place of four which will give you a total of 135 volts on the binding post marked 180. Apply 90 volts to the binding post marked 135. Keep the 4½-volt C-battery as specified but substitute a 22½-volt block in place of the 45-volt battery so that you will get 22½ volts minus on the binding post marked C minus 40 in Fig. 2.

Dry cell

(Continued on page 139)

For dancing, you want all the volume you can get to drown out the shuffling of feet on the floor

When someone is reading, you should be able, without sacrificing tone quality, to soften the music so as not to disturb him

Controlling Radio Volume

How to Make Programs Loud or Soft without Distortion

By JOHN CARR

IT IS easy to control the water flowing out a faucet. Just turn the knob to suit yourself. The amount of water that comes forth, will have no effect upon its quality. Regulating the volume of music or speech that flows from your radio loudspeaker is not so simple. How to control volume without introducing distortion is a problem that is attracting much attention, especially now that power tubes and modern audio transformers have made possible reproduction of radio programs at a high volume level without sacrificing tone quality.

There are times when you want every bit of volume you can get. Dance music, for instance, should be loud enough to drown out the shuffling of feet on a polished floor. On the other hand, dinner music would serve as a pleasant background for table conversation. And there are occasions when one member of the family desires to listen to a speech while others are reading. Accurate adjustment of volume without loss of tone quality is essential in such a case. This volume control should be capable of regulating down to complete silence with exactly the same effect on all the tone frequencies.

In the early days of radio, without today's tonal possibilities, it was simply a question of applying enough amplification to bring the music up to audibility. All radio receivers were fitted with interstage jacks so users could plug the loudspeaker in after the first stage of audio amplification and eliminate the second stage altogether.

THIS crude method of volume control now is obsolete. Cutting out the last audio stage means that you also cut out the power tube, and the tone quality suffers. Furthermore, this method doesn't give close control.

As improvements on the interstage jack system, there are three possible methods of controlling volume on any radio receiving set. You can regulate the strength of the signal as it is brought into the receiver. You can adjust the amount of radio amplification, or you can decrease the audio amplification if the signal is too loud.

From a theoretical point of view, the first of these methods, that is, regulating the signal strength before it is acted on by the tubes in the receiver, would be ideal. Unfortunately, however, the methods available for regulating the strength of the signal before it is operated upon by the set are open to several practical objections. Of course, the simplest way of reducing the strength of the incoming signal would be to reduce the length of the antenna, but you would hardly wish to crawl up on the roof and snip off a piece of the antenna every time you wanted the music weaker. The same effect can be obtained by reducing the number of turns in the antenna coil in the set, but this leads to trouble with the tuning. Every time you change the antenna coupling the setting of the first tuning dial also must be changed a trifle, or slight distortion produced by inaccurate tuning is introduced.

This method of control also sharpens the tuning. However, if your set employs several stages of radio-frequency amplification, you will find it impossible to cut down a powerful local station to anything much less than full volume.

YOU can build a realistic wooden model of the *Spirit of St. Louis*, the monoplane which Charles Lindbergh flew from New York to Paris. An article on page 76 of this issue describes just how to go about it. Full size drawings of the model, contained in POPULAR SCIENCE MONTHLY blueprint No. 67, also are available to aid you in the work.

A better way to get input control is to connect a variable resistance across the antenna and ground. By adjusting to lower and lower resistance values, more and more of the signal energy flows through the resistance instead of through the coils in the set. If the resistance can be made low enough, volume can be reduced almost to the vanishing point. Introducing a resistance into the circuit in this way lessens the tuning, but this is not objectionable because you need to control the volume only on stations that are received with considerable strength and which are, in consequence, rather broad tuning anyway. A variable resistance suitable for this purpose should have a range from several million ohms to a very low point for adequate control.

Changing the volume by adjusting the amount of radio-frequency amplification is one of the most popular methods of control both in factory built and home assembled radio receivers and the simplest way of this type of control is to use an adjustable rheostat to regulate the temperature of the filaments of the frequency amplifier tubes. While distortion is theoretically possible as a result of this form of control, practically the control is almost perfect.

TWO peculiar effects are noted with this form of volume control. If you use a trickle charger for your A-battery and keep it turned on except when the set is in use, you will find that a few minutes after the set is first turned on and the volume control adjusted, the music or speech will become noticeably weaker and the volume control will have to be readjusted. This apparent weakening of the signal doesn't indicate anything wrong with the set. It is caused by the dropping back to normal of the storage A-battery voltage and can be avoided by turning the set on a few minutes before you intend to use it.

The other effect shows up only if you are using a B-battery eliminator. You may notice that the volume control is very abrupt. A slight change of the controlling rheostat may produce a great change in the strength of the music. This effect, most pronounced in a set having several stages of radio-frequency amplification, is due to the poor voltage regulation of the B-eliminator as compared with the uniform voltage obtained from batteries.

Attempting to control volume by adjusting audio amplification is open to at least one objection if the set is powerful. No matter

(Continued on page 127)

Sam Loyd's Brain Twisters

Put Your Wits in High Gear

See How Quickly You Can Solve These Six Puzzles

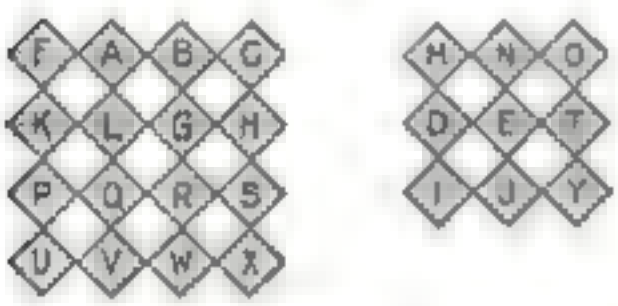
A FASCINATING course in mental calisthenics is embraced in the new test puzzles presented here from month to month by Sam Loyd, world famous puzzle maker. This medley of problems ranges from mathematics to word juggling and picture diagrams. Each one of them will help you get a line on your mental abilities.

To test yourself, keep track of the time it takes you to arrive at the correct answers; then turn to page 139, for the correct answers and your rating.

Have You an Eye for Form?

TO COMBINE these two clusters into one larger five by five square of diamonds in which the letters will run in alphabetical order from top to bottom rows horizontally, is the problem which is presented for you to work out.

The white squares are to be disregarded.



First, mentally picture the objective larger square with its orderly arrangement of letters. Then plan into how few pieces it will be necessary to cut the two groups at their connecting points in order to build the five-by-five square.

This problem will test your ability to visualize clearly and to estimate the dimensions of geometrical forms. See page 133 for the solution and your rating.

A Brain Teaser in Letters

AN INTERESTING test of your vocabulary consists in transforming one word into another by dropping a single letter.

The first example is answered by the word rock.

Answer the others as quickly as you can, time yourself, then turn to page 139 for correct answers and your rating.

1. Drop the letter K from a stone and leave a fabulous bird. 2. Drop R from a crustacean and leave a vehicle. 3. Drop I from earth and leave the sun. 4. Drop C from a coating and leave corrosion. 5. Drop D from a glen and leave a measure of cloth. 6. Drop E from a Christian festival and leave a flower. 7. Drop G from a gridiron and leave a small stream. 8. Drop E from an organ and leave a deer. 9. Drop S from a stake and leave a vessel. 10. Drop R from a scent and leave an appendage.

Count the Children

THE census man leaning over a farmer's fence asked, How many children have you?

Plenty, the farmer said, "and I find that all the feeders eat just as much as the big ones. Since the last twins came, a barrel of flour runs out three days sooner. I figure that if we had four more children, the barrel would empty in four days less time than it now takes."

Assume that the father, mother and each of the children consumes a like quantity of flour. Can you tell how many children there are in the family? Time your answer, then turn to page 133 for your rating for mathematical ability.

Can You Reason It Out?

AS PROVING necessity is the mother of invention it is told that the popular "Twenty Five" p. well known through the West, was invented by a party of snow-bound miners whose stock of games was limited to the possibilities of a single well-worn die.

The game is played by two persons.

The object is to see who can get 25 first, or compel his opponent to carry the score above that total.

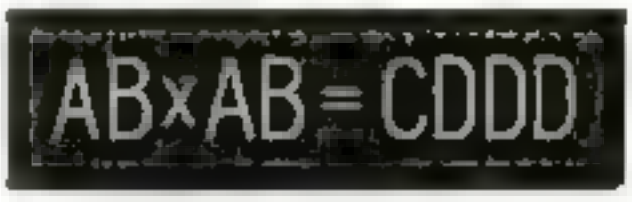
The first player "sets the pace" by calling out any number from one to six. Suppose he commences with 5. The second player throws the die and adds his number to first player's chosen number. Let us say the second player throws 3, making the score 8. The die is no longer thrown; the element of calculation begins.

The first player now turns the die over, but, according to the rules, must give it merely a quarter turn, so as to bring to the top any of the four sides, 1, 2, 5 or 6. Suppose he took 6, the score would be 14. The second player, let us say, turns up 4, making the score 18. The first player then turns up 6, carrying the total to 24, which wins, because his opponent cannot pass 25 by turning up any of the four numbers which can be shown by making a quarter turn. Going above 25, he loses, as explained.

What the miners did not discover is that the game involves a knotty problem when the question is asked: Who has the better chance of winning the game, the first or second player? What do you think about it? Would you prefer to "set the pace" by calling the first number or be the second player who makes that one chance throw of the die? Here's an excellent way to measure your reasoning powers. Turn to page 131 for your rating.

One That Needs Analysis

A SCHOOLMASTER asked his class to substitute figures for letters in the equation shown on the blackboard. What figures can be substituted for the letters A, B, C and D and have the



equation work out as shown? This unusual problem will test your talent for mathematical analysis. Time yourself, then turn to page 135 for the correct solution and your rating.

Have You Imagination?

CONSTRUCT one word from the letters in each of the following lines:

1. Ravine near it.
2. Treat five men.
3. Permeable tin.
4. I see a worm.
5. Stir in temper.
6. None in class.
7. Men find 1 die.

You'll need all the imagination you possess to find the solutions. Time yourself. Then, on page 133, see your rating and how many words you had correct.

Sam Loyd has prepared another set of his fascinating new test puzzles, which will appear in next month's issue.

Is Your Home Safe *from* Fire?

How to Avoid the Hazards That Cause a Blaze Every Minute Somewhere in America

By JOHN R. McMAHON

THE guests at a house-warming party had been promised a surprise and they were quite excited about it, making all sorts of wrong guesses.

It would be a show with a thrill, something appropriate to a house-warming and at the same time a scientific test. What on earth could it be? Some of the guests laughed at the idea of getting a thrill, but the host offered to bet with the skeptics that their hearts would skip at least two beats.

"This way, ladies and gentlemen," he said at last.

He opened a bedroom door and grouped them at the entrance so they could see everything inside. Then he picked up a gallon can of kerosene and doused its contents on window curtains, bedding, floor rugs and articles of apparel hanging in a closet.

While his guests watched in amazement, he laid a fuse of twisted newspapers to the doorway, lighted a match and put it to the end of the fuse. The flames crept slowly toward the oil-soaked floor rug and the oil-dripping bed.

At the moment the fire reached the kerosene, and a half instant before the room became a roaring furnace, the host calmly shut the door and a servant's voice announced:

"Dinner is served."

Some of the guests had more than their share of the promised thrill. Their emotions ran from fascinated horror to panic and the verge of hysterics. The skeptics admitted their hearts jumped.

The company sat at dinner and the host explained that he was testing the merits of his new fireproof house. He would give that fire a couple of hours to burn itself out. After the bedroom furnishings were consumed, the fire would find nothing more to feed on, since walls, floor, ceiling, doors and windows were incombustible.

After dinner the bedroom was visited. It was gutted. A bed of ashes represented its contents. But no essential damage had been done to the house. The dwelling was certainly fireproof, for it was of solid concrete.

THIS classic housewarming took place in the vicinity of New York several years ago. A better demonstration along the same line could be given today. There could be a similar fire in a bedroom and the after-view would show nothing destroyed except paper, cloth and the like. Every item of furniture would be unscathed, for it would be all metal despite its perfect resemblance to wood. We now can have metal chiffoniers, rocking chairs, armchairs, stands, tables, whatever we want.

With a fire every minute, America leads the world in home burnings! Our yearly fire bill is over half a billion dollars

America leads the world in home burnings with a fire every minute! Fifteen thousand lives were lost and $539,428,838 in property destroyed by fire in 1925, the last year for which figures are available. The lives cannot be restored and much of the property is not insured. For years the public has been warned and exhorted and lectured and scolded on the topic of our national fire record. But every year America's fire bill climbs steadily upward.

I BELIEVE we are all a little case-hardened on the fire peril. Figures don't impress us. We sniff at statistics. Fire? Sure, send for the engine. Maybe it will be worth looking at.

There is a chance to freshen jaded interest in a vital subject by pointing out that fire protection is just one aspect of a comfortable and economical home. A house is not well built and livable unless it is reasonably safe against flames. When you safeguard against the red-tongued monster, you also bar out rats, mice and other vermin, you checkmate molds and insects that insidiously destroy woodwork. At the same time the house is warmer in winter and cooler in summer. You save fuel. You reduce upkeep materially, having less repair and replacement. You attain lasting satisfaction and long run economy.

But the fireproof house is costly, more than the average person can afford?

Yes, if it is one hundred percent proof like the dwelling where the owner put a match to his oil-soaked bedroom.

Then is it worth while to spend money on partial and incomplete protection?

It certainly is, especially when you know the vulnerable points and guard them. Everything in life is subject to a percentage of ill chances, and it is wisdom to guard against the worst or most of them. A soldier protects his head with a "tin hat," although his body is all exposed. A mechanic at a tool-grinding wheel wears goggles to save his eyes and ignores minor hazards to his bare hands. If your house is protected against half or three fourths of the possible fire perils, it is safe to that extent. Every detail of protection counts and is worth having.

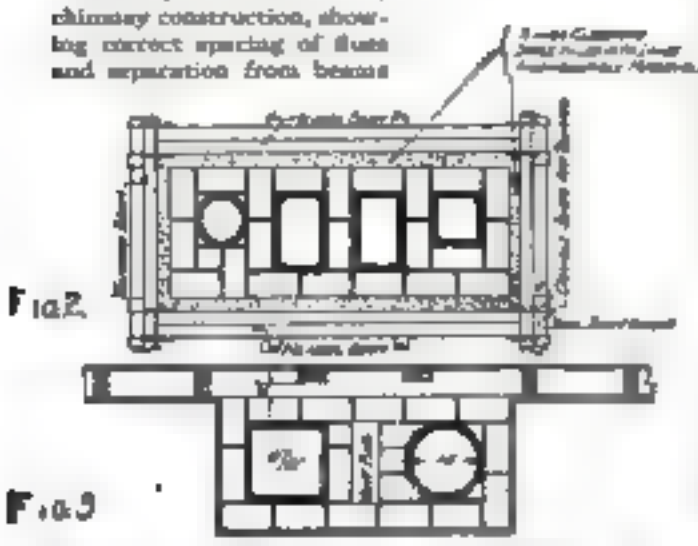
Where would you start to safeguard a house against fire?

At the foundations, unless the walls are masonry. Too many frame dwellings have too low foundation walls, so that the woodwork is close to the ground. The wood becomes damp, rots and is subject to attack by such formidable insects as white ants. At the same time there is a standing invitation to the fire fiend when autumn leaves drift against the wall or rubbish accumulates and someone is careless with match or cigarette. It is well to have foundation walls extend at least two feet above grade. And this protection should not be whittled down by wooden steps resting on the ground, wooden supports under porch, or latticework screening porch. Let the first two or three steps be concrete, have masonry piers under the porch, and use a strip of ornamental wire fencing below wood latticework. If wire does not please the eye, it can be hidden with shrubs.

THE same precautions should be taken with a near-by garage and other outbuildings. The value of high foundations merely from the standpoint of dryness and wood preservation is now widely recognized. Many houses of moderate age are being raised at considerable expense just to amend a fault that could have been avoided easily and at small cost in the first place.

What does fire-stopping the walls mean?

It means blocking at intervals the air spaces between studs in wood frame construction. If this is not done, the air spaces—usually about four by fourteen



Two fireproof methods of chimney construction, showing correct spacing of flues and separation from beams

FIG. 2.

FIG. 3

nches in use—become potential fire flues that extend vertically from the foundation to the roof. Thus a cellar blaze may shoot to the attic in no time. It is difficult to fight such an insidious hidden fire, however early discovered. The first line of stops should be on the foundation wall between ends of floor joists. Fill these spaces with any kind of masonry, including mortar rubbish. You can do this any time with an old house. On the other hand, the second line of stops can only be applied in the course of new construction. They belong halfway up the first story and may consist of short pieces of two-by fours fitted between studs in a horizontal line. Some builders insert these pieces at an angle so that they serve both as fire stops and as structural braces, which is a fair compromise method. There should be another line of stops, or equivalent cut-off construction, at the beginning of the second story and again halfway up the second story wall. Finally, it is advisable to fill with masonry or mineral wool the spaces between rafter ends where they rest on the wall. Here the doubled "plate" stops the vertical stud spaces and the object is mainly to safeguard the eaves from interior or exterior attack.

How can those parts of brick-on frame wood stop fire?

THEY at least retard fire by cutting off draft. If you can slow down a blaze by ten minutes, you may save your house. Slow-burning is a technical term of merit applied to heavy wood construction. The insurance rate is lower on such a building, which is usually a factory type. Here I want to emphasize the benefits of fire-stopping, apart from the question of conflagration. We may never have a fire in our house, but it is certain that rats and mice will ramble all through the walls and even break into the living quarters unless they are blocked by the methods described. A few vermin may indeed persist despite wall-stopping, but it is easier to deal with a few than with an army. There is also the important benefit of insulation against heat and cold. Unless there are stops, air circulates freely up and down the wall, making drafts and distributing heat and cold between cellar and attic. Dead air, or confined air, insulates and stabilizes temperature.

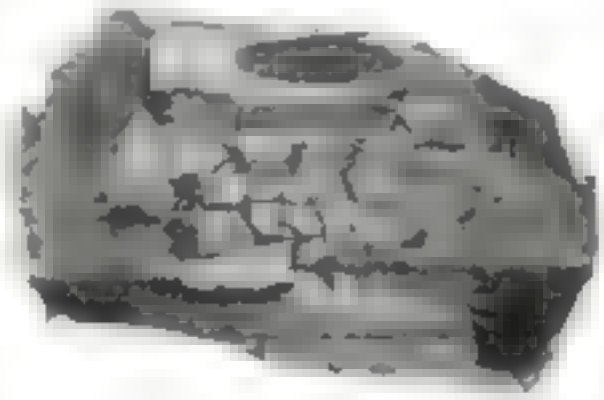
Does a double floor of wood give any fire protection?

Yes, considerable, and that is another example of how fire safety coincides with good construction. A double floor is harder or slower to burn just because it is thicker. The case is like that of the two-by-four stops, or it is like lighting a match compared with igniting a plank. Fire needs much air to prosper. It eats more quickly through a single floor and establishes a draft to accelerate havoc. The resistance of a double floor is much increased by having a layer of asbestos paper between the two layers of flooring. Such a combination, with a metal lath and plaster ceiling below, is suitable to protect living quarters from a built-in garage and is rated to resist fire for a period of one hour.

Is it worth while to have exterior walls of masonry when everything inside is combustible material?

Inviting fire—chimney bricks on edge, unbonded, and in contact with roof. Note cracks

Where a roof blaze started. An unlined chimney on wooden supports in a garret



Here floor was built into chimney wall. Vibration loosened brick and started fire

Yes, both for the degree of protection obtained and for the saving in upkeep. You don't have to paint masonry or watch out for decay. However, the upkeep argument loses force in the case of wood frame that is covered with stucco in first-class style. Here the surface is the same as with stuccoed hollow tile or concrete block and should require no more attention. The great majority of so-called masonry houses are of wood construction inside, including floors, partitions and roof. While there is decided value in an incombustible exterior, it is a mistake to exaggerate it or to regard such a dwelling as "fireproof." Undue confidence may lead to dangerous carelessness. Such houses are subject to most of the usual hazards and every day numbers of them are completely burned out. Heat cracks and topples the outside walls; or they are pulled down by falling floor joists, unless the latter are self-releasing. After the fire there is salvage of masonry units and perhaps some of the first story wall.

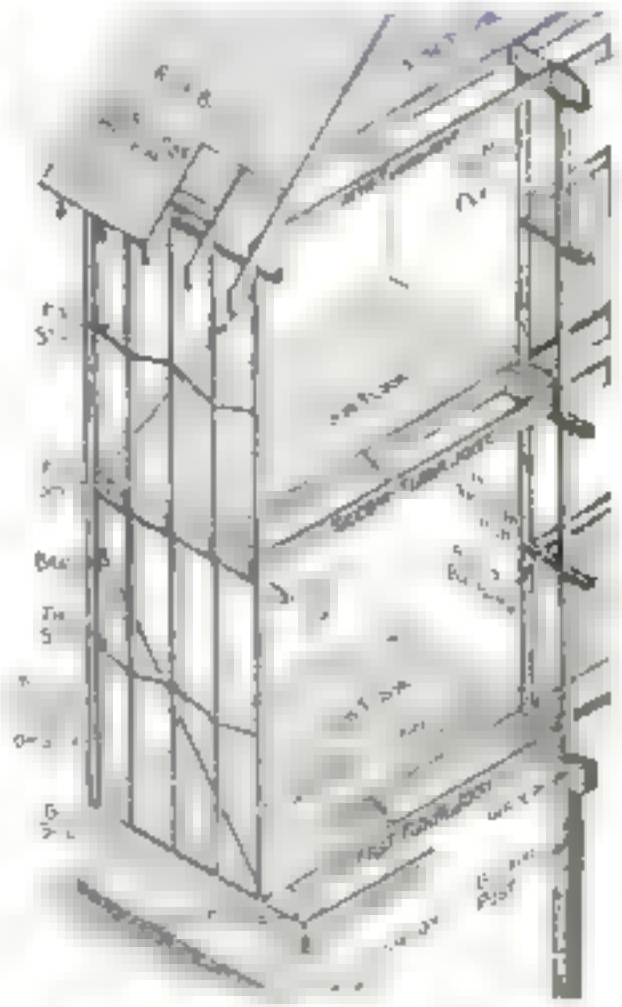
What about protecting the combustible interior of such a house?

Plaster on metal lath for partitions and ceilings is the first choice. Then comes gypsum wallboard, which is made in sections four feet wide and long enough to fit the height of any room. Gypsum cannot burn, while the large size of wallboard has advantages, including labor saving. The superiority of plaster on metal lath is chiefly due to the reinforcement of wire mesh or the equivalent, which gives rigidity and also holds the plaster in place when attacked by fire. There seems to be an opportunity here for some inventor to reinforce wallboard, solving the problem of its proper fastening to studs. Such a ready-made surface would be practically equal to a hand plaster job.

IN HANDWORK it is well to remember the added merit of back-plastering, that is, applying a layer of mortar on the back of lath between studs. Thus the total thickness of plaster is increased and the lath is wholly covered on both sides, preventing rust if metal and decay if wood, while improving fire resistance in the latter case. A wood frame partition wall is not accessible for back plaster on both sides. In this case we might back-plaster the more hazardous side, as that towards the kitchen, especially the wall near stove or range.

Can the requirements of fireproofing be reconciled with insulation against heat and cold?

They can be fairly compromised at least. Mineral wool, asbestos and porous plaster substances are unburnable. The other insulating materials are generally fire resistant, whether by nature or by treatment in manufacture. Wallboard made of sugar cane or wood fiber is usually protected by a layer of stucco or plaster, and such (Continued on page 1)



Protecting frame dwelling with fire stops that block dangerous flues between studs and help to insulate against heat and cold

Handy Kinks for Motorists

Easy ways to oil springs and stop curtains flapping—Other useful ideas for your car

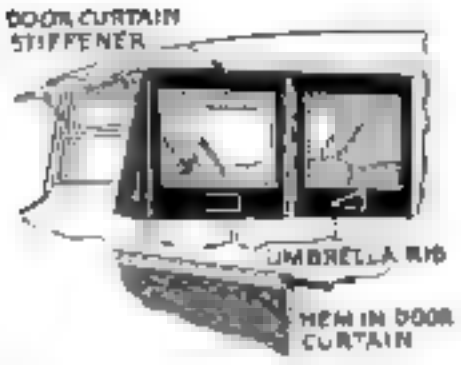


Fig. 1. How an old umbrella rib will stiffen window curtains and keep them from flapping in the wind

Ten Dollars for an Idea!

DR. J. W. AUSTIN, of San Jose, Calif., wins the $10 prize this month for his suggestion of the whistle attached to the overflow pipe (Fig. 2). Each month POPULAR SCIENCE MONTHLY awards $10 in addition to regular space rates to the reader sending in the best idea for motorists. Other published contributions will be paid for at usual rates.

WHEN the door curtains on your car begin to get old and floppy you probably will find that they sway in or out with each gust of wind and consequently afford little protection from the weather. An ingenious way to stiffen them is to open the end of the hem along the top and insert an old umbrella rib, as shown in Figure 1.

Whistle Indicates Boiling

YOUR motor always seems to overheat and start boiling the water, if you have the misfortune to have it happen at all, at night when you can't see the thermometer on the radiator, or when, in the daytime, your attention is concentrated on the road or the scenery.

Of course, if you are going slowly in traffic the escaping steam will rise to warn you of trouble, but when you are traveling fast, you may not notice that something is wrong until serious damage has been done. A good way to make an infallible steam indicator is to solder a small whistle to the end of the overflow pipe, as shown in Figure 2. Day or night, the shrill blast of the whistle blown by the escaping steam will warn you to stop and investigate. A warning signal of this type is particularly valuable if your car is fitted with an automatic or hand-controlled radiator shutter. With the hand-controlled type, the whistle will blow and warn you to open the shutter if you happen to forget it

New Battery Terminal Tool

FIGURE 3 shows a home-made tool that will prove effective in removing a battery terminal that is stuck fast to the lead post because of excessive corrosion. The device is a lever arrangement fitted with claws somewhat like those of a hammer. Pressing down on the lever lifts up on the claws inserted under the cable clamp, and presses down on the post to which the clamp is stuck

A Simple Spring Oiler

AS SHOWN in Figure 4, you can make an efficient spring oiler out of a piece of sheet iron, a broad lamp wick and a bolt. After you have cut a strip from the sheet iron long enough to reach a half inch or so below the edge of the spring on each side, place the strip on a piece of wood and with a center punch make a number of holes in the section that will cover the top of the spring. Then drill two holes, one at each end, fit the lamp wick in place over the spring, and bend the sheet iron as shown in the illustration. Oil squirted on the top of the oiler will settle through the small holes at the bottom of the dents made by the center punch, and the wick will carry the oil down to the edge of each leaf.

Best results will be obtained if you fit two oilers on each spring, one on each side of the center fastening. If the springs are badly rusted, it is a good idea to mix a little kerosene with the oil

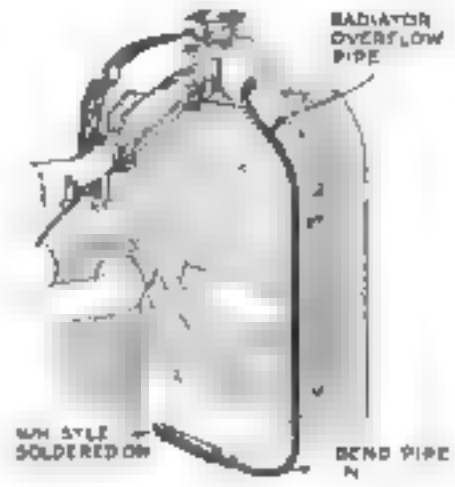


Fig. 2. Whistle soldered on the end of the radiator overflow pipe will give warning of overheated motor

Fig. 3. Lever and hook device above is useful in removing corroded battery cable terminals

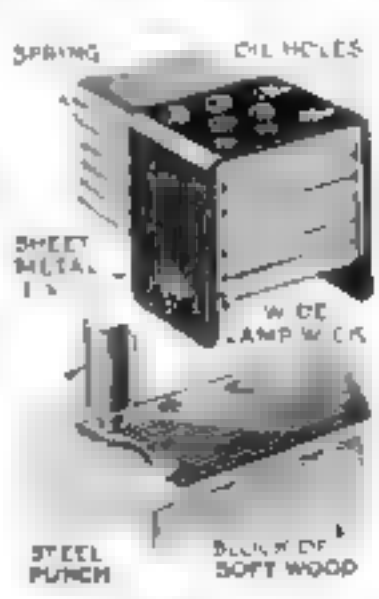


Fig. 4. Ingenious spring oiler made from a strip of sheet iron and lamp wick

An Emergency Hose Clamp

IF YOU happen to strip the threads on a hose clamp bolt so that it will no longer hold tightly, you can make a substitute out of a piece of wire and a large cotter pin, as shown in Figure 5. As you will note from the illustration, turning the cotter pin by means of a nail tightens the wire by winding it around the cotter pin. Ordinary galvanized iron or even copper wire will do.

In fitting a hose connection it is a good idea to coat the end of the pipe with thick shellac before pushing the end of the hose on it, as shellac is insoluble in water, gasoline or oil and consequently will help make a tight joint.

Spiked Board Pulls You Out

ORDINARILY only one rear wheel gets stuck in a mudhole in the road. If the mud is very soft, even chains may not prove of much use. However, you will find that a length of board fitted with wooden cleats, and through which a number of long spikes have been driven, as shown in Figure 6, will provide a path for the wheel out of the hole. Another board nailed along the edge will prevent the wheel slipping off. When not in use it can be strapped under the running board.

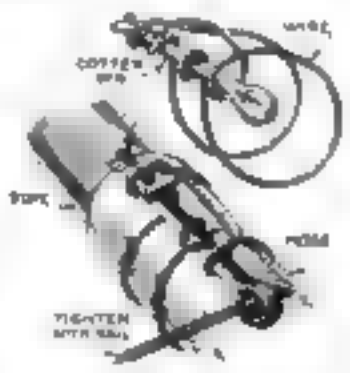


Fig. 5. Piece of wire and cotter pin makes hose clamp in an emergency

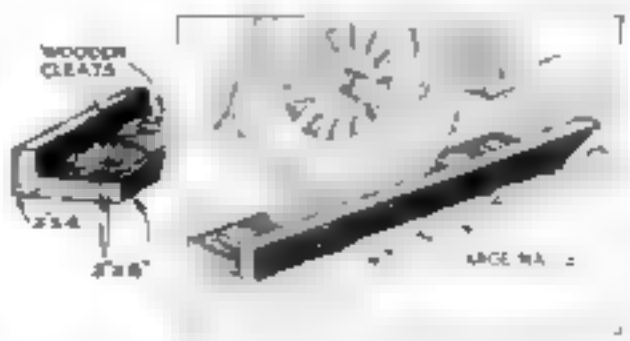


Fig. 6. A cleated and spiked board, with a guide rim along one edge, will help in getting your automobile out of mudholes

When Your Motor Sizzles

Gus discovers a complication of little ailments that cause a radiator to boil in summer

By MARTIN BUNN

"I suppose it steams on all the long hills," Gus observed. "Yeah," replied Hardy, "it sure does. Blows off steam like a teakettle by the time it gets to the top"

GUS WILSON always insisted that hot weather didn't bother him, but Joe Clark, his partner in the Model Garage, knew better. Whenever the mercury began to flirt with the top of the thermometer, Gus started grumbling.

"I never saw such a lot of pickyune jobs!" the old auto mechanic growled as he mopped the perspiration from his brow with a handful of waste. "I'm sick of cleaning the muck out of carburetors, changing spark plugs, putting new bulbs in headlights and going out on trouble calls to find out that some bonehead's motor doesn't 'mote' because he forgot to fill the gas tank!

"See what that bird outside is honking his horn for, Joe. I suppose it's something important—needs a new hub cap, or something.

"Better go out and have a look at that car, Gus," said Joe a few minutes later. "He says it overheats, and it sure is hot enough to fry eggs on, but I can't seem to locate the trouble."

"Probably needs a new fan belt," Gus muttered disgustedly as he started for the door.

But Gus's bored expression rapidly changed to one of interest as he progressed with the inspection of the motor in the customer's car. The motor was overheating—that was quite obvious. Although it had been stopped for several minutes, heat waves still were rising from it in a shimmering cloud and there was a smell of scorched paint mingled with the odor of hot, oily metal. Yet the fan belt was in place and the radiator appeared to be full of water.

"WHEN did you first notice any trouble, Mr ?" inquired Gus.

"Name's Hardy—I sell sewing machines," replied the car owner. "If it was a sewing machine that wasn't working right I'd know what to do, but this outfit sure has my goat! It'll do fine as a cook stove but it's a total loss as an automobile. I bought it second hand last month and it's been broiling my feet ever since.

"Start it again and let me listen to it," Gus requested.

Hardy stepped on the self-starter and the motor started at once. It ran smoothly without a sign of a miss. Gus opened the filler cap on the radiator and squinted down the hole. "Speed her up a bit," he said.

Apparently satisfied with what he saw, Gus closed the radiator cap. Then, after the motor had been running for several minutes, he felt all over the front of the radiator and proceeded to place his hand on various parts of the cylinder block and cylinder head.

"I suppose it steams on all the long hills," Gus observed.

"Yeah, it sure does," replied Hardy. "Blows off steam like a teakettle on a rampage by the time it gets to the top. I have to fill the radiator with water every time I get gasoline."

"There's a hill right near here," Gus suggested. "I'd like to see how it acts."

"Hop in," said Hardy. "You won't get cold feet in this car at any rate."

But Gus had forgotten the heat for the time being. He was too much absorbed in finding the cause of the overheating, and so he carefully observed the way in which the car accelerated and appeared to be listening intently for queer noises. They started up the hill in good style. About halfway up the water began to boil, and a few hundred feet farther on the motor developed a hollow ringing knock that seemed to come from only one cylinder.

"Better stop and let it cool off a bit," Gus advised when they reached the top of the hill. "Then we can go back," he added. "I know what's wrong. It's what the doctors call a complication of diseases."

"THAT means a hopping big repair bill," groaned Hardy, "and I haven't sold a single sewing machine this week. About how much is it going to set me back?"

"Don't worry," said Gus with a smile. "You can have a powerful lot of things fixed on an automobile for a few dollars if they are all little items. And all of yours are.

"I don't remember ever having run into such a queer combination," continued Gus. "Not one of the things that are wrong with this car would amount to anything by itself. But each one has a tendency to cause overheating, and working together they sure have put the motor on the bum.

"There's nothing radically wrong with the cooling system. Barring one particular trouble, it's just a sort of general let down in operating efficiency. Take

the radiator, for instance. It looks clean enough if you just glance at it. But if you inspect it carefully you'll notice that a lot of dirt is caked in the openings. That dirt has two bad effects. First, it cuts down the amount of air that the fan can suck through the radiator. Second, it prevents the air from touching the actual metal surface, and so keeps the radiator from getting rid of its heat to the air. The fan belt is slipping because it's too loose, and that still further slows down the air flow through the radiator. And I think a measurement will show that the angle of the fan blades is not right. They are set nearly parallel to the radiator. They should be at a greater angle so as to scoop more air through at each revolution. Whoever had the car before you must have bent them that way to make the motor run warmer in cold weather, and then he forgot to bend them back again in the spring.

"The pump seems to be working all right. When I looked in the filler opening in the radiator, I could see the water whirling around, due to the increased speed of the pump when you stepped on the throttle. And there really isn't much that can happen to the pump, anyway, as long as it keeps on working at all. But circulating the water through the radiator and cylinder jackets won't keep the motor from getting too hot if the radiator is coated with mud on the outside and full of muck, scale and rust on the inside and the jackets are in the same condition. And from the looks of things I'm pretty sure that's the case with this motor."

"You don't mean to say that a little dirt will make any car overheat as bad as this one does, do you?" exclaimed Hardy skeptically.

"Not by itself, perhaps," admitted Gus, "but there are other things wrong. Your carburetor is set for a rich mixture. The spark doesn't advance as far as it should, and I'm certain that the muffler is choked with carbon. Those three things would be enough to cause a little overheating on a warm day, even if nothing was wrong with the cooling system."

"When the motor gets real hot there's a funny knock," said Hardy. "Has that got anything to do with the cooling system?"

"Probably," replied Gus. "Maybe the dirt in the water jacket has collected over one cylinder to such an extent that the head overheats at that point. Or perhaps some of the holes between the cylinder jacket and the head jacket are stopped up. That would keep the water from circulating over that particular head and it would naturally get hotter than the others. We'll see what happens when I flush it out."

By this time they had arrived back at the garage and Gus got busy at once.

"It'll probably take at least an hour, Mr. Hardy; do you want to wait?" Gus inquired as he started to drain the radiator preparatory to flushing it out with a strong solution of lye.

"Sure I'll wait," replied Hardy, fanning himself with his hat. "Nobody wants to buy sewing machines in this weather, anyway. I'll get me a nice cold bottle of soda pop and maybe take a snooze under that tree while you work!"

After the water was all out of the radiator, Gus filled it with the lye solution and ran the motor at a rapid rate until it had warmed up again. Then, with the motor still running, he opened the drain petcock at the bottom of the radiator, stuck the water hose in the filler opening, and turned on the water fast enough to make up for the amount that ran out at the drain cock. At the end of about fifteen minutes of this treatment, the water that issued from the bottom was perfectly clear, indicating that all the dirt that had been in the cooling system was out, or at least as much of it as could be removed by that particular method of cleaning.

"I hope it got the dirt out of that clogged-up cylinder head," Gus muttered to himself. "If it didn't, I'll have to take the cylinder head off."

WITH the inside of the system cleaned out, Gus set to work to clean the crusted mud out of the radiator fins. He put the nozzle on the hose and set it to squirt a solid stream about the size of a pencil. Then he shot this stream through the openings in the radiator from the inside so that the water and the dirt it dislodged would be thrown out at the front.

Bending the fan blades so that they would pull more air took only a moment, and then Gus examined the fan belt.

"I could tighten it up and it would run all right, I suppose," he thought. "Still, it's worn to a frazzle, and it'll soon give out anyway. Guess I'll put in a new one."

Gus tackled the ignition next. He found that one of the control levers had become bent so much that it didn't push the timer case around far enough when the spark was advanced.

"A CHIMNEY sweep would feel right at home on this job!" Gus exclaimed as he started cleaning out the muffler. But a stiff wire brush enabled him to finish the disagreeable work in a short time.

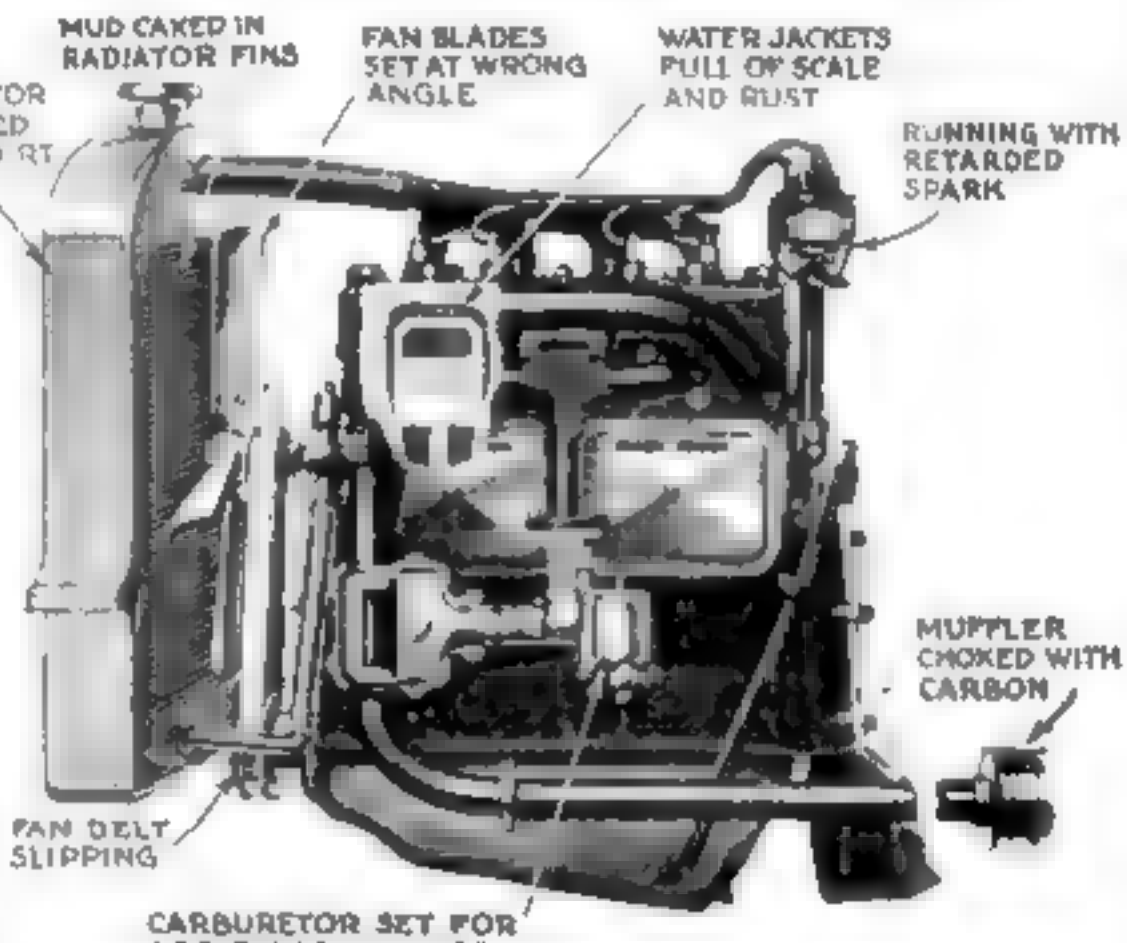
"All ready for a test, Mr. Hardy," Gus called a few minutes later to the sewing machine salesman who was snoring peacefully under the tree.

Once more Gus climbed in behind the wheel and they headed for the test hill. This time the car arrived at the top without any sign of boiling. The lye evidently had done its work and opened up the clogged passages in the cylinder head, because the knock also had disappeared.

"There's one point you ought to remember, Mr. Hardy," Gus suggested. "The motor got up this hill without boiling, but if the hill had been twice as long it probably would have boiled if I had kept it in high gear. When you get on a steep, long hill in hot weather, especially when you are driving with the wind, you'll find that the motor will stay a whole lot cooler if you shift to second instead of trying to go all the way up in high. There's two reasons why the motor cools better in second speed under such conditions. One is that the motor turns over faster and the fan consequently pulls more air through the radiator. The other is that the pump circulates more water through the cylinder jackets, and carries off the heat much more quickly."

"I thought I heard you say you were tired of picayune jobs," grinned Joe Clark to Gus after Hardy had departed.

"Humph!" growled Gus. "My idea of a picayune job is one that anybody can do. The ones on that car had you stumped!"

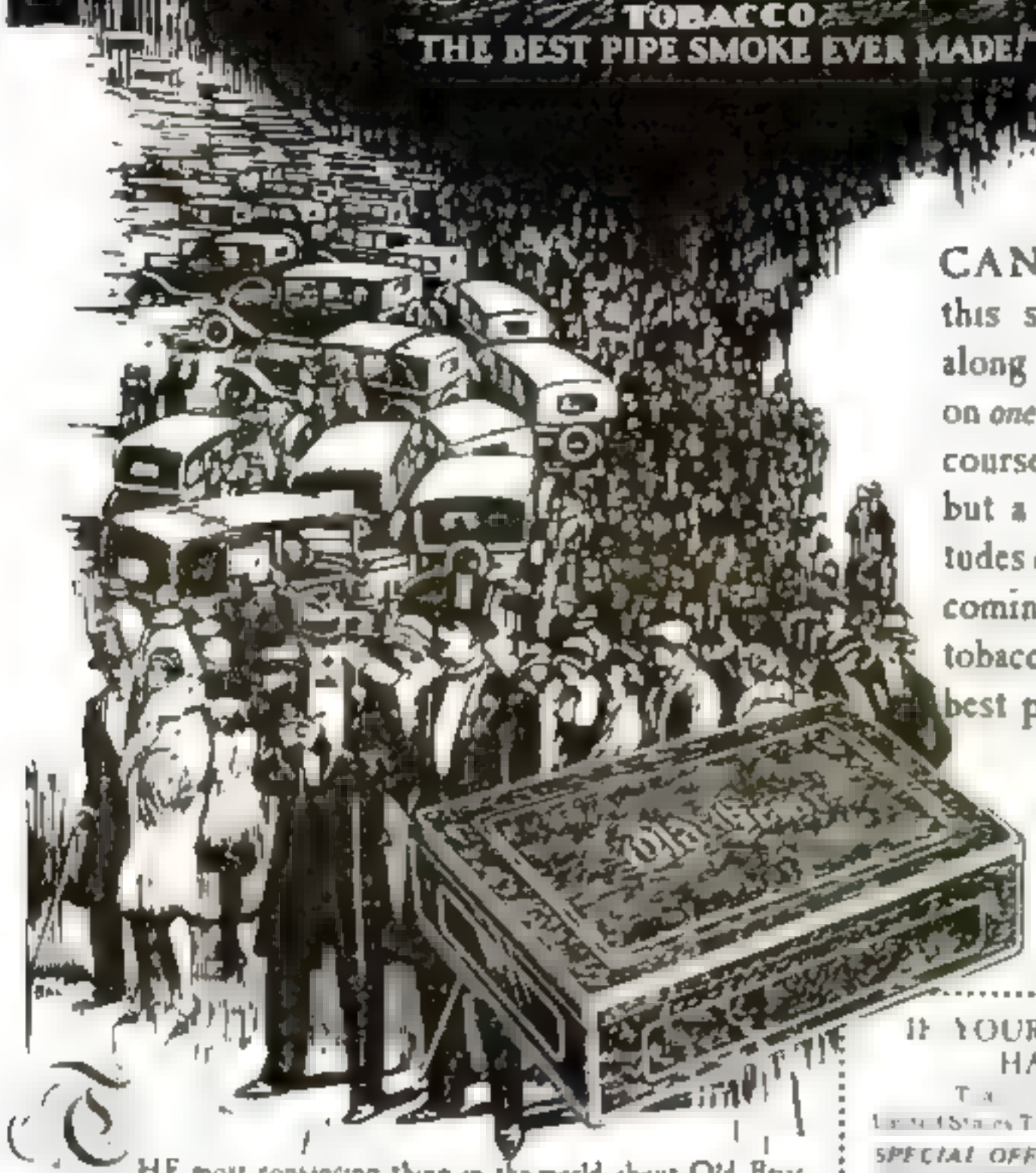


Any one of the troubles indicated on this cross section diagram may cause your engine to overheat in hot weather if the trouble has developed to a serious stage

Old Briar

TOBACCO

"THE BEST PIPE SMOKE EVER MADE!"



CAN YOU IMAGINE this surging theatre throng along Broadway all agreeing on *one* star as the greatest? Of course not! Yet this throng is but a fraction of vast multitudes of smokers who are welcoming and praising *one* pipe tobacco—Old Briar—as "the best pipe smoke ever made."

THE most convincing thing in the world about Old Briar is the whole hearted praise of the smoker himself. It's just plain common sense that pipe smokers are turning to the best tobacco they can get. They are entitled to it!

Light up your pipe full of Old Briar. Draw in the ripe fragrance of this wonderful tobacco. Enjoy its full, pleasant aroma—its extra smoothness—its comfort. Smoke it awhile. Notice how mild and cool it is—how completely satisfying! Now, you know why vast multitudes of pipe smokers are welcoming Old Briar—why even the ladies enjoy its fragrance.

It has taken generations of tobacco culture and years of scientific knowledge in the art of mellowing and blending, to produce Old Briar. Step by step Old Briar has been developed—step by step *perfected*.

And, every day, thousands of pipe smokers are proving for themselves that Old Briar is the best pipe smoke they ever had.

IF YOUR DEALER DOES NOT HAVE OLD BRIAR

[illegible] United States Tobacco [illegible] Richmond, Va. U.S.A.

SPECIAL OFFER [illegible] pipe [illegible] Tear [illegible] name [illegible] Dealer [illegible] receipt of this coupon, we will mail to you the regular Old Briar 50c humidor tin. In addition we will include one 25c pocket package of Old Briar—extra—you [illegible] your dealer's name. Send no money but pay the postman only 50c when he delivers your order. Tear out the coupon now, while it's handy.

Print Name

Address

City and State

Your Dealer's Name

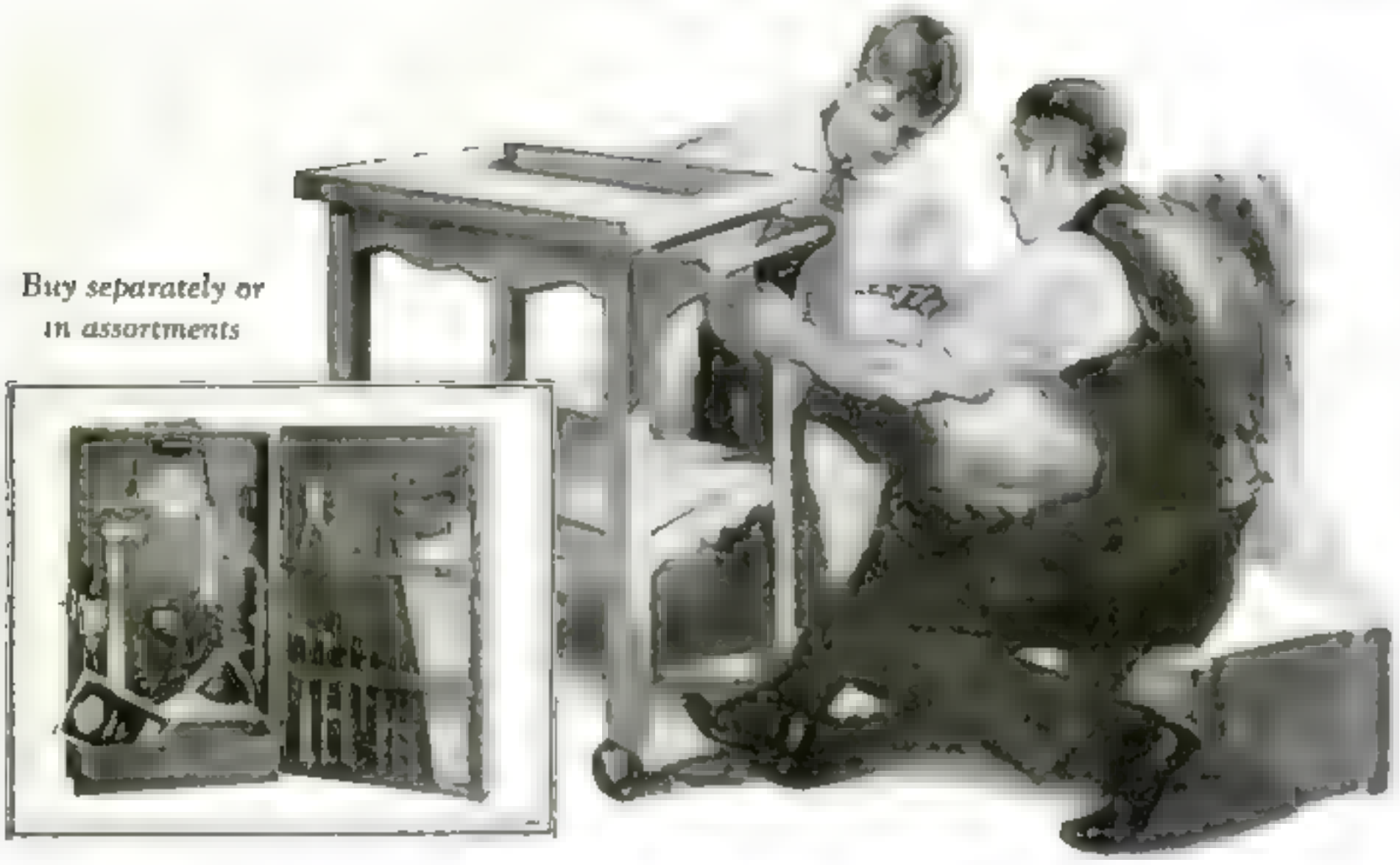
Address

If you prefer—send stamps, money order or check with coupon

Of all the pleasures that man enjoys, pipe smoking costs about the least. And the additional enjoyment of a *pipeful* of Old Briar costs only a fraction of a cent more than ordinary tobaccos. Every box and package of Old Briar has our unlimited guarantee.

TO DEALERS: *Old Briar is sold in Pocket packages at 25c and Humidor boxes at 50c, $1.00 and $2.00. If your jobber has not supplied you, write us and we will send you a supply by prepaid Parcel Post at regular Dealers' prices.*

UNITED STATES TOBACCO COMPANY, RICHMOND, VIRGINIA, U. S. A.



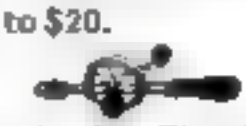
A social celebrity in wood!

Make a Tea Wagon from Plan No. 17e

THE tea wagon has long occupied the center of the stage at afternoon teas, bridge parties and informal luncheons. Why not make one for your own home? Stanley Plan No. 17e gives you all the necessary designs and details of construction. You will find it comparatively easy to make.

But it certainly doesn't pay to gamble on results by using inferior tools. In the long run the best tools are really the cheapest to use. Carpenters the world over prefer Stanley Tools. They know that the name Stanley assures durability, correct design, and right "feel." And Stanley Tools are first choice in thousands of manual training classes.

You can buy Stanley Tools separately and so collect your own set. For your convenience in buying there are also complete sets of Stanley Tools in chests at a wide variety of prices from $15 to $95. Or there are assortments in strong cardboard boxes containing directions for making your own tool chest. Priced from $5 to $20.



Your hardware dealer has Plan No. 17e as well as other Stanley Plans for making useful articles, or he can get them for you. The plans cost only 10c each. Ask him also for small Catalog No. 8e50, which shows many useful Stanley Tools. It is free. If he cannot supply you, write to The Stanley Works, New Britain, Conn.

The best tools are the cheapest to use
Ask your hardware dealer

STANLEY TOOLS

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

A Ship-Model Vane

How to Make a Striking Ornament for Your House, Garage or Camp

By Capt. E. A. McCann

WHICH way does the wind blow? If you love the outdoors, care anything for boating, or watch the weather closely for any reason whatever, you often wish to know the answer to that question. And what can possibly answer it more appropriately than a ship-model weather vane?

It is not difficult to make a vane of this type. Indeed, it is far less trouble than to construct a decorative model of the mantel-shelf variety. The cost, too, is but a fraction of what you would have to pay for a ship-model vane in one of the few exclusive stores that have foreseen the new vogue for these charming gable decorations and are offering them for sale.

To simplify your work still more, a blueprint has been prepared with complete drawings and a full size outline of the hull of a weather-vane ship, which may be traced directly on the wood. This you can obtain by sending 25 cents to the Blueprint Service Department of Popular Science Monthly, 250 Fourth Avenue, New York, for Blueprint No. 66 (see page 87).

As we are dooming our ship to an eternal head wind, the "Flying Dutchman" would, of course, be the ideal motif, but as only those who "believe in fairies" have ever seen her, she had to be rejected. The American *Grand Turk*—one of the "Letters of Marque" ships—has been chosen because she was a picturesque little brig, which helped to win the War of 1812. This ship, of 310 tons, was built by Elias Hasket at Salem, Mass., in 1812. She captured three ships, twelve brigs, seven schooners and eight sloops—a wonderful record for so small a vessel. In 1815 she was sold and became a merchantman.

In our vane we are going to simplify everything very much. A silhouette is what we want. And it must swing easily to the lightest puff of air, yet withstand the fiercest gale.

For materials you will need the following: White pine, 1 pc. ¾ by 6 by 20 in. for hull and 1 pc. ¾ by ¾ by 10 in. for channels, dowel sticks, two ¼-in. and three ⅜-in., for spars and guns, hard wood, ⅛ by ¼ by 6 in. for cathead and bumpkins; copper wire, 1 spool each No. 18 and No. 22; thin sheet copper, 7 by 12 in. for sail and flags; thick sheet copper, 6 by 6 in. for letters; brass tubing, ⅛ (outside diameter) by 27 in., 3/16 by 11 in., and ¼ by 48 in., or other heavier pipe or rods, depending upon the material obtainable and the method of mounting; a suitable flange, such as a square brass floor flange, for the lower end of the mast support; wood or copper for gilt ball; 2 brass washers with ⅜-in. holes; a short piece of ⅜-in. brass rod, or collar pins; ¾-in. brass nails, thick and thin; enamel, stain and varnish; solder.

THE tools necessary are those that are to be found in every household: a fine-tooth hack saw, miniature plane, screw-driver, brace and ⅛- and ¼-in. auger bits; ⅛ and 3/16 in. bit stock twist drills or breast drill and ⅛- and 3/16-in. drills; tin snips or old shears, soldering iron, files, pliers, ⅛ and ¼ in. wood chisels, knife, rule, try square.

Cut the hull stock to the shape shown full size on Blueprint No. 66 and on a smaller scale on page 96. Shape the lower edge to leave a keel about ¼ in. square and round off the outer corners along the bottom. Cut the stem and sternposts to the same thicknesses as the keel and round the ends of the hull to meet them. The rudder is indicated by being cut a bit thinner. Note that the hull where the

(Continued on page 96)

Running *Your* Outboard Motor

How to Mount It Correctly and Look After It So As to Insure the Most Reliable Service

By EDWARD V. PARKER

THE sight of a young boy wending his way down to the waterside with the complete power plant of his motor boat dangling at the end of one skinny arm would have caused considerable excitement in the days when a two-horsepower gasoline motor of the marine type weighed several hundred pounds. But the perfection of the outboard motor has made such a sight quite common these days.

Modern types of these remarkable motors are so skillfully designed that they will send your boat through the water hour after hour without showing any signs of distress. However, the outboard motor, like any other piece of fine machinery, requires a certain amount of attention for best results.

It must be used in a boat of the correct type. You can clamp an outboard motor to the stern of almost any boat or canoe, but for best results remember that an outboard motor exerts as much power as several horses, and if you apply that power to the stern of a rickety old boat, something is bound to get go in time. The strain imposed by driving the old tub through the water may open up the seams and even loosen up the transom so that you may suddenly discover that your fine outboard motor has broken away and headed for Davy Jones' locker. Make sure that the boat is in good condition although, of course, it does not have to be of heavy construction.

To eliminate all chance of the motor's slipping, always tighten the clamps as tight as you can by hand, but don't use a wrench.

The motor will drive the boat through the water much faster if the propeller is down far enough so that it operates in undisturbed water. Have the propeller blades below the line of the bottom. This is particularly important if the boat is of the flat bottom type.

BY FAR the most popular type of outboard motor has a twin-cylinder engine. These engines are of the two cycle type, which means that there is one explosion for each revolution of the crank shaft. Both cylinders fire at once so that the jar of the power stroke in one cylinder is exactly balanced by that in the other. Vibration is reduced to the minimum by this arrangement.

As the two pistons travel toward the cylinder heads, gasoline and air are drawn by suction into the crank case.

The lubrication of an outboard motor is taken care of by adding a good grade of oil to the gasoline before filling the tank

Then, when the pistons move toward each other on the power stroke, the charge of explosive mixture in the crank case is compressed. Near the end of the stroke each piston uncovers a slot in the cylinder wall that is connected by way of an opening in the casting with the crank case. The charge compressed in the crank case rushes into both cylinders, forcing out the exploded gases of the old charge, and the cycle of operations is repeated.

In effect, therefore, the two-cylinder outboard motor is equivalent to a single cylinder motor except that by using two pistons and two cylinders, vibration is reduced and much more power is developed than would be practical with one large cylinder.

As there are no valves, the possibility of trouble is greatly reduced; so long as the motor is supplied with gasoline and the sparking apparatus stays on the job the motor is bound to keep on running.

Lubrication is taken care of in the simplest possible way. The oil is mixed with the gasoline before it is poured into the fuel tank. When the gasoline is drawn into the crank case, the air mixes with the gasoline, leaving the oil to lubricate the bearings and pistons of the motor. There is no chance for trouble with the lubrication so long as you make sure that the proper amount of good quality gasoline engine oil is mixed with the fuel. Outboard motor manufacturers specify in each case the grade and amount of oil to each gallon of gasoline.

To mount an outboard motor properly it is sometimes necessary to cut down the transom

BE SURE to mix the oil with the gasoline before you put it in the fuel tank of the motor. *Don't* pour the two into the tank separately and expect them to mix in the tank. They won't do it. The heavier oil will settle to the bottom of the tank and be drawn into the carburetor or mixing valve and you may not be able to start the motor at all.

Most outboard motors have gasoline tanks that hold about one gallon; that is enough fuel to run the motor at full speed for approximately two hours. You will find it necessary to refill the tank several times on a long trip, so take along one-gallon cans of gasoline to which the right amount of oil has been added. It is a wise precaution to have at least a can or two more in the boat than you are likely to use. You never can tell when a head wind or an adverse tide will upset your calculations.

The oil mixed with the gasoline takes care of the lubrication of all the parts of the motor itself. The bevel gears which drive the propeller are packed with grease and it is advisable to add a fresh supply of grease after each two hundred miles of use. The instruction book accompanying the motor will show you how this should be done. In

(Continued on page 106)

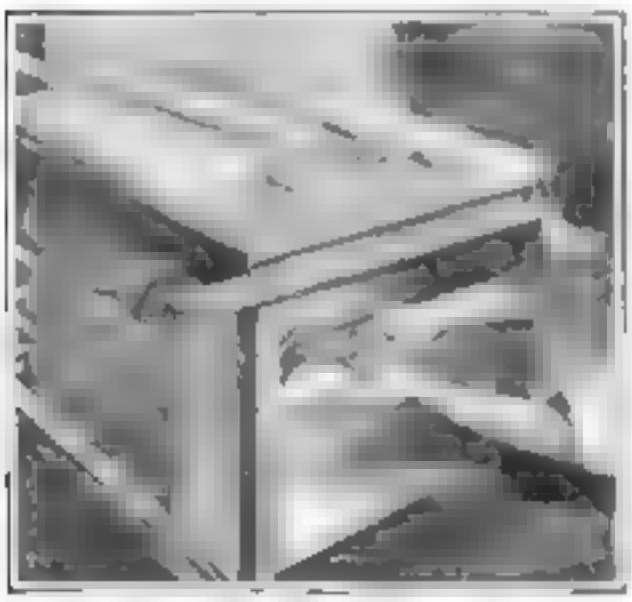
Kitchen Table *Serves* As Bench

It Does Double Duty When Drawers and Shelves Are Built into It to Hold Tools and Supplies

By E. E. ERICSON

EVERY housewife needs a kitchen table; every husband wants a workbench. In a small apartment there is not room enough for both. Neither does it happen very often that the kitchen table is in use when the man wishes to do woodwork, model making or tinkering, for that is usually in the evening after the housework has been done.

Why not solve the problem, then, by



Putting a shelf into the end compartment. The bar clamp keeps the legs from spreading

fitting up a kitchen table so that it may be converted temporarily into a workbench when occasion requires, and, when the job is done, returned to its primary use by clearing the top and putting away the tools—making out of it, so to speak, a Dr. Jekyll and Mr. Hyde.

THIS I did by making use of a table which was already at hand. It had square, slightly tapered legs and was built quite substantially.

A sketch was first made to scale in order to save time in the construction and to make sure that things would work out just right.

The scheme finally decided on provided for long drawers in front and a set of shelves at the right end. The drawers were made long enough to receive saws and a steel square. The upper one was to be used for tools and the lower ones for other equipment and materials.

The necessary lumber order was made—Douglas fir for the additional framing, the doors and drawers, and plywood for the paneling and drawer bottoms. For the runs for the drawers and the framework around them, "blind stop" material, which is carried by lumber yards for window-frame construction, was obtained, and thus much labor in ripping and planing was saved. For the base or lower rails, 1 by 3 in. material was used. This also can be obtained cut to size as a rule; if not, it can be made by ripping either a 1 by 6 in. or 1 by 8 in. board in two, depending upon whether the finished pieces are wanted a little less or a little more than 3 in. in width.

After the material was prepared, the frame was fitted in place. Plain "butt" joints were used in most places, although it would not be very difficult to use mortise-and-tenon construction where the bottom rails, or base pieces, meet the legs. A pair of long cabinet maker's bar clamps were used to hold the work together while the nailing was done. Although by no means essential, these clamps help materially in producing a square and solid job.

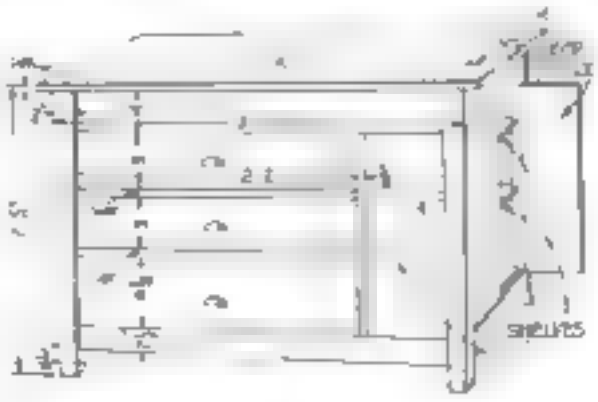
THE upright piece at the right-hand extremity of the drawers was fitted to the upper and lower rails with half-lap joints and nailed from the back. The seat or rabbet for the panels was made by nailing small, square strips back of where the panels were to go and "toe-nailing" the panels in place from the front. If a "plow" or universal plane is available, the new rails can be grooved in advance to receive the panels, but it would be most difficult to make grooves in the legs and upper rails of the table.

The lower shelf in the end is supported at the ends on the rails, while the end rail is fitted outside of it and nailed in such a position that half the thickness of the shelf is exposed, as shown in the drawing; this forms a stop for the doors.

Two doors for the cabinet were made from 1 in. thick wood and hung with 1½-in. butt hinges. To guarantee against warping, two cleats may be screwed on the ends of the doors. A small elbow catch is placed on the left door, and a cupboard lock or catch on the other.

If a plane for grooving the fronts and sides of the drawers to receive the three-ply bottoms is not available, this handicap can be overcome either by buying ready-made drawer material from the mill or lumber yard, or by fastening the drawer bottoms by the method previously described for securing the panels to the framework—that is, by nailing square cleats in place to hold the bottoms.

Homemade wooden drawer pulls would



The completed bench. Dimensions are governed entirely by the size and type of table

serve the purpose admirably, but in this case metal pulls were used in order to save time.

No vise or bench stop is shown, since the intention is to keep the top clear for general kitchen use. Hand screws will be used for vise and bench stop, as illustrated in the article, "A Bench That Takes No Room," on page 73 of the May, 1927, issue of POPULAR SCIENCE MONTHLY. No particular harm, however, would be done by cutting in a metal bench stop of the type shown in the article just mentioned. Such a stop would be a material help in planing and, since it may be lowered to the level of the top, it would cause no inconvenience when the table is used for other purposes.

A little paint or varnish, applied to the new parts, or, better still, painting the entire job anew, will make this a piece of furniture which would be presentable in any kitchen and of practical utility to both the housewife and the handy man.

The doors are hung with 1½-in. hinges and fitted with elbow catch and cupboard lock

How to Mix White Lead Paint

MIXING a glossy white lead paint for exterior use is not the task that many amateurs imagine. When only a small quantity is desired, choose as a measure a can that will hold about one half the amount of paint desired. Fill this with white lead and empty into a much larger can. Then fill the measure with four fifths pure raw linseed oil and one fifth turpentine. Stir well and pour a little at a time into the white lead mixing thoroughly. Stir in the tinting color, if any is to be used, and add approximately one tablespoon of liquid turpentine dryer for each pint of oil used. Strain through cheesecloth. For a priming coat, this paint should be further thinned with linseed oil and turpentine.

Lindbergh's Plane, Toy Size

How you can easily build a realistic wooden model of the "Spirit of St. Louis"

By
D. M. CLAYTON

ASK any small boy whether he would like to have a toy model of the Ryan monoplane, *Spirit of St. Louis*, in which Capt. Charles A. Lindbergh flew from New York to Paris, and see what he says.

Like a flash he will answer: "You bet I would. It'll be the greatest toy I've got!"

And you can make one for him quite easily, or, better still, let him do the job himself with a little help whenever he needs it.

The model is surprisingly realistic when neatly painted. It will serve not only as a toy but for display purposes or as a decoration. It may be hung by means of a fine wire near the ceiling of a sun porch, children's room or any other room where a novelty of this type is appropriate. Another use for it is as a weather vane, mounted like the scale model described in the article begun on page 74.

Full size drawings from which the work can be laid out directly have been prepared, No. 67 in the POPULAR SCIENCE MONTHLY series of blueprints, listed on page 87.

Materials are needed as follows:

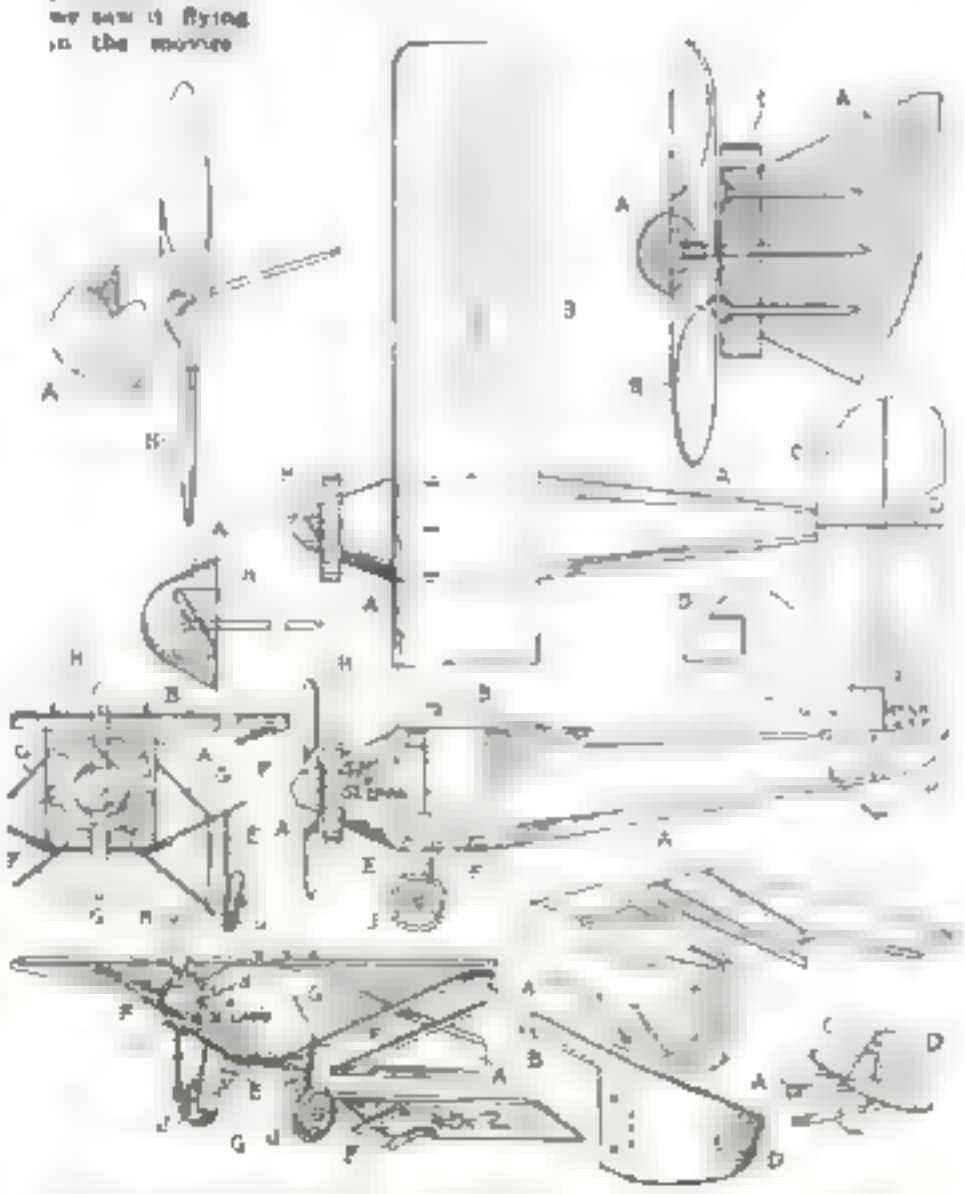
FOR the body or fuselage (A), 1 pc. clear white pine or other soft wood, 2¾ by 3 by 14 in., which can be built up by gluing several pieces together; wing (B) 1 pc. ¾ by 3¾ by 23 in., pine or hard wood (a scrap piece of pine siding is excellent); tail (C), 1 pc. ¾ by 3 by 6 in. hardwood or three-ply wood (it may be used instead); rudder (D), 1 pc. heavy tin, sheet brass or copper 3 by 3 in.; shock absorbers (E), 2 pcs. ½ by ¾ by 2½ in. hardwood; struts (F) ⅜ by ½ by 23 in. hardwood (or brass or aluminum, ⅜ by ⅛ in.); struts (G), ⅜-in. birch dowel 12 in. long; propeller (H), ¾ by ¾ by 5½ in., and motor (I), ¾ by 2½ by 2½ in. white pine; wheels (J), ⅛ in. thick 1¼ in. in diameter, hardwood; glue, assorted small nails, screws and washers; sandpaper; scrap of thin tin for fittings; light gray brushing lacquer or enamel, aluminum paint, and black lacquer or paint.

The finished model looks just like the real plane did when we saw it flying in the movies

Either transfer the outline of the fuselage to block A from Blueprint No. 67, or lay it out from the accompanying drawings and saw, plane and whittle it to shape.

Now measure back from the nose ¾ in. and cut off the cone-shaped point. Save this to fit over the hub of the propeller later on. Measure ¾ in. further back and cut off another section, which is discarded. In its place, glue and nail the motor (I), a piece ¾ in. thick and 2½ in. in diameter, with nine equidistant slots to indicate the separation of the cylinders.

The wing and tail members are next cut out. The wing is glued and screwed to the fuselage 1¼ in. back of the motor. The tail (C), if made of wood, is glued and nailed in a recess cut in the upper surface of the fuselage. If it is of tin, no recess is needed. The rudder (D) is inserted in slots and nailed, as shown.



How the parts of the plane are shaped and assembled. All are shown full size on our Blueprint No. 67, which you will find helpful (see page 87)

WHEN wings and tail members are in place, cut out the shock absorbers. Round the corners, as if they were streamlined. Then fasten them to the fuselage and wing by means of the various struts shown, using small tin fittings and thread or wire bindings to reinforce the joints where necessary.

Each wheel is mounted by means of a round-headed screw ¾ in. long, with a washer between the wheel and the shock absorber.

The propeller is whittled and attached to the center of the engine block (I) with a nail and washer in such a way that it will spin freely. The nose, previously cut from block A, is then notched and glued to the propeller.

Apply two coats of light gray brushing lacquer or enamel to all, except the cone-shaped front end and propeller which should receive two coats of aluminum paint. Paint the engine windows, wheel tires, lettering and markings black. Note that N X-211 appears on top of right wing and on under side of left wing.

Timesaving Mail Box Has Hinged Bottom

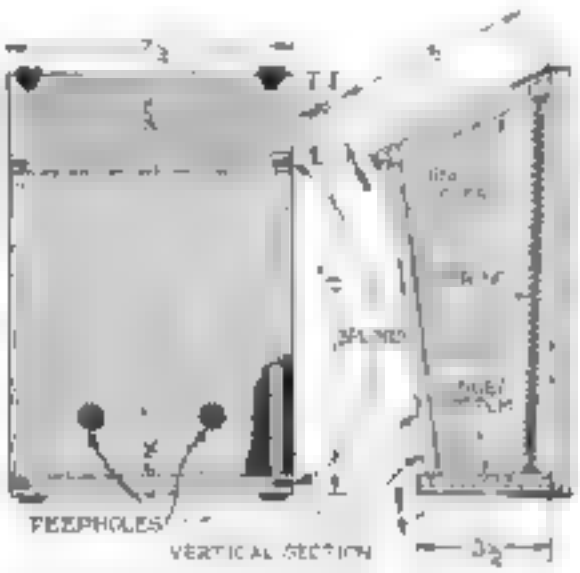
By R. K. Bailey

How letters are removed from the box

MAIL placed in the letter box illustrated is removed simply by pulling open the hinged bottom, which is then closed automatically by a small spring. This feature allows the mail to be withdrawn very quickly and easily, it also permits the box to be placed high out of the reach of small children.

The top, bottom and back are ½ in. thick, the front and ends ⅜ in. In assembling the box the ends are set back ½ in. Note that the end grain of the top and bottom covers is reinforced with a hard wood spline, ⅜ by ¾ in. A suitable spring may be obtained at the curtain-rod counter of any ten-cent store. If desired, a square opening may be cut in the front of the box and the edges rabbeted to receive a piece of glass.

The box may be painted, or it may be stained and finished with a coat of outside varnish.



Front and end views of the mail box. A spiral spring holds top and bottom shut

A Plug That Fits Three Holes

This plug will fit a triangular, a square, and a T-shaped opening

IN AN article, "A Square Peg in a Round Hole," on page 90 of the July issue, a puzzle was shown which called for the whittling of a single plug to fit three holes of unlike shapes, the first triangular, the second square and the third T-shaped. A plug that will accomplish this is illustrated above.

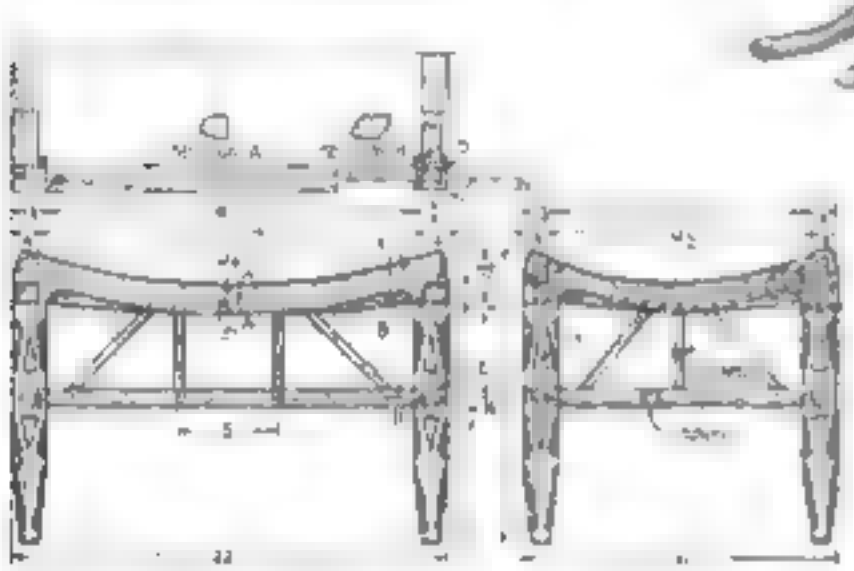
If you are interested in puzzles, don't fail to obtain our Blueprint No. 65 (see page 87). It contains a variety of puzzles, including 19 of the Chinese cross variety, a movable letter puzzle and several puzzles like that mentioned above.

Furniture You Can Build Easily

Distinctive Stool or Low Bench in Egyptian Style - Hall Rack for Mail Tea Tray Stand or Table

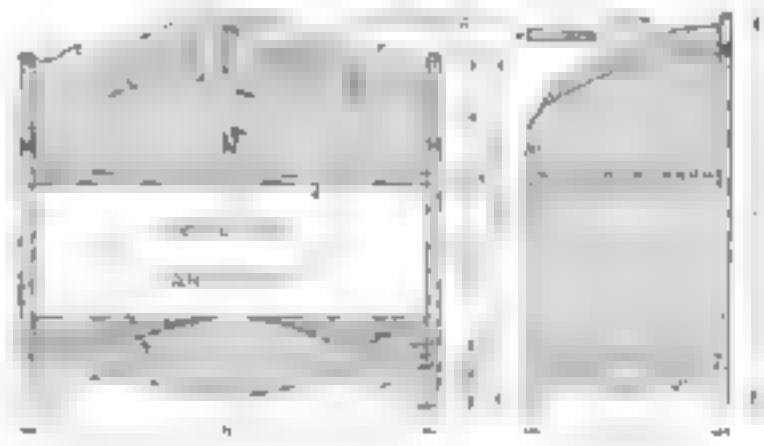
EGYPTIAN in type the mag ne stool illustrated has a flex ble leather seat that instantly adapts itself to the slightest change in position. It may be used in any room not entirely devoted to one style or period.

Oak, ash or some other tough wood should be used. The top or seat rails are halved at the corners and fastened w th screws (C). The lower rails (E), which are 1 in. in diameter, are held with ¼ in. pins (D). Fit all joints carefully and assemble with a good grade of hot glue.



Since the uncovering of marvelous objects of art in Tut ankh Amen's tomb, Egyp tian motifs are being used more in furni ture. This stool is a charming example.

The mail rack illustrated at the right may be varnished or gaily lacquered and decorated w th brilliant transfers.



The chamfered decorations may be cut with knife, spokeshave, drawknife or chisel and finished with file and sandpaper. The triangles (F) are incised about ⅛ in. and stamped with the point of a nail.

The stain should harmonize with or match the color of the leather. The finish may be two or three coats of thin shellac rubbed with No. 4/0 sandpaper and polished with wax, or two or three coats of clear brushing lacquer.

The stout but soft and flexible leather for the seat should be soaked until pliable enough to bend around the corners. After the leather has dried thoroughly it may be polished with wax.

IF THE mail rack shown above, w th compartments for letters and shelf for magazines, is placed conveniently in the hall of any house that shelters a large family or many guests, it will simplify the handling of the mail.

The piece may be made of red gum, whitewood, mahogany or, if it is to be enameled or lacquered, almost any inexpensive close-grained wood.

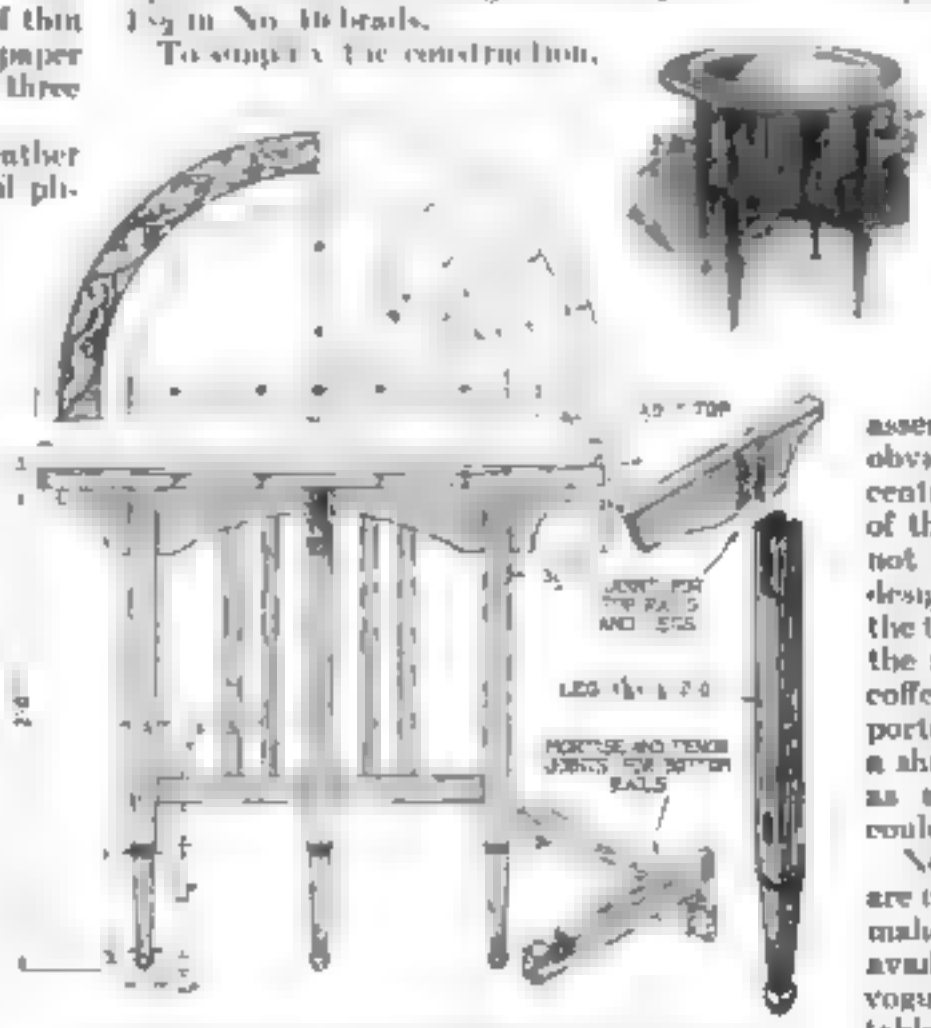
The ends and shelves are ½ in. thick; the back and front pieces and partition, ¾ in. After the ends have been sawed, cut ⅜ in. deep grooves in them to receive the shelves, one of which is 7⅛ by 15¾ in. and the other 7 by 15¾ in. Cut a groove of the same depth in the upper shelf to receive the partition. In each case stop the groove ½ in. back from the front edge (section A-A). Note that this makes it necessary to notch both shelves and partition ½ by ½ in. at the front corners.

Rabbets are cut in the ends to receive both the back pieces. The base is cut in square. Assemble with glue and 1¼ and 1½ in. No. 16 brads.

To simplify the construction, the grooving and rabbeting may be omitted and the parts assembled with plain butt joints. In that case the shelves are 1½ in. long.

Perhaps the easiest way of finishing the case is with brushing lacquer in gray, buff, jade, Chinese red or any of the brilliant colors now so popular. If desired, art transfers may be applied in the center of the front rail and on both ends.

The case may also be finished with stain and varnish to match the woodwork in the hall, in which case lettering such as is shown, or other suitable ornamentation, may be applied with a wood carver's ⅛-in. veining gouge, the space between being stamped with the point of a sharp-ened tenpenny nail.



An attractive tea tray table, the original of which was constructed in teakwood and ornamented with hand carving

A. P. K. DEWEE of Newcastle, Natal, South Africa, who is a subscriber to POPULAR SCIENCE MONTHLY, designed and built the beautiful tea tray stand illustrated. He used teakwood and embellished the top with a band of hand-carved ornamentation.

The construction of the table is clearly shown in the assembly drawing and details. It is obvious that the diameter of the central recess depends upon the size of the tea tray to be used. If it is not desired to have a tray, the design may be modified by keeping the top perfectly flat, in which event the piece would make a charming coffee stand or a table for supporting a large cone loudspeaker, a ship model, or the like. For use as a breakfast table, the piece could be built on a larger scale.

Not many amateur mechanics are in a position to obtain teak, but mahogany and walnut are usually available. In view of the present vogue for colored furniture, the table would be attractive if built of inexpensive wood painted.

Toy Glider Made with Feathers

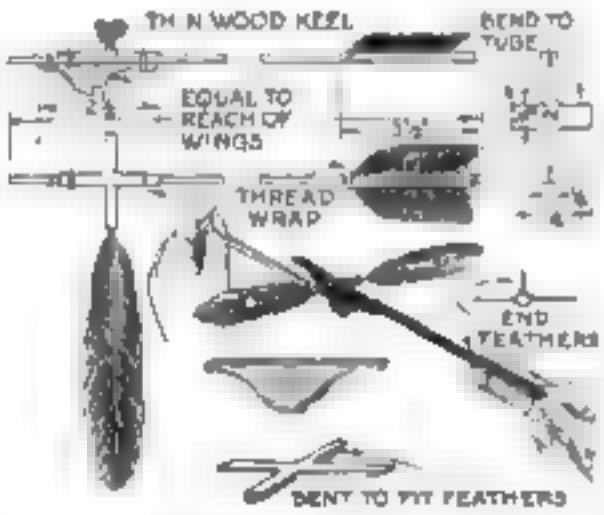
By F. Clarke Hughes

A feather glider, shot into the air with a rubber band, will fly surprising distances

THE toy glider illustrated consists of a few large feathers, a piece of tin a ¼ by ⅛ in. wooden rod and a strap of ⅛ in. thick wood. The proportions depend upon the length of the wing feathers so the example shown these are 7½ in. long.

By pressing the feathers with a warm iron, they may be straightened. The wooden members and tin mounting should be painted some bright color. The exact position of the parts is determined by trial flights.

When properly balanced the glider takes the air smoothly and flies steadily. A rubber band is used as shown to shoot it forward.



How to make and fly the toy. The feathers are inserted in a slip bent out of thin tin

After trying various materials for the crosstrees of ship models, such as the "Sovereign of the Seas" (Popular Science Monthly Blueprints Nos. 31, 32 and 33), I find that ⅛-in. hard rubber is excellent.

Mark the outline on the rubber with a pencil or trace the shape by using carbon paper. Then score the lines with a sharp knife and fill the cuts with white chalk so that they can be followed easily with a coping saw. Sandpaper the rubber before painting it.—J. E. T

This seal on a radio, coal or oil burner advertisement signifies the approval of the Institute of Standards. See page 6.

Cutting Threads Accurately

How to Simplify a Task Machinists Find Tedious

By Charles Kugler

MOST machinists at times have to cut a really accurate thread, perhaps for a thread gage, a tap, or a precision adjusting screw. Yet to make precision threads is one of the most tedious jobs in the art of tool making. It is not alone a question of adequate tools, but of the most painstaking patience.

Cutting threads is usually such a simple operation with taps and dies that we lose sight of the accurate workmanship which must be put into those taps and dies to enable them to produce accurate threads. The methods suggested here are such that any mechanic with the necessary patience can make commercially accurate threads.

In the first place, the lathe should be one that will turn straight and true. Its lead screw should not be taken on faith, for even though it is new, there may be an error.

By setting up a lathe as shown above and diagrammatically in Fig. 1 below, a machinist can test the accuracy of the lead screw

IN FIG. 1 is shown a set-up for testing the accuracy of a lead screw for pitch of thread. A block, B, is clamped to the faceplate of the lathe in such a position that the indicator, A, will allow the spindle to be stopped at precisely the same point at each revolution. The indicator should be on a surface gage placed on the V's of the lathe so that it can be moved along the V's in a straight line.

Another block, C, is clamped to the carriage and an indicator D is attached to a block, E, which is clamped to the bed of the lathe. Gear up the lathe to cut any desired thread, say three to the inch. Then set both the indicators to read zero. Move indicator A out of the way and turn the lathe spindle a certain number of revolutions, say eighteen, stopping the spindle on the indicator at the zero reading. Now, if a 6-inch end measure F, is put between block C and indicator D, the indicator will read zero, provided the lead screw is correct. If it is not, the indicator will show the amount of error.

It is clear that any intermediate points on the lead screw can be checked by using shorter distance pieces, or an inside micrometer, and that the method can be used to test with precision any portion of the length of the lead screw.

Having determined that the lathe and its lead screw are satisfactory, the grinding of the tool should be given attention. It is obvious that the form of the finished thread will depend entirely upon the shape of the tool, and to insure that the tool will be correct, an accurate gage must be provided. The ordinary gages cannot always be relied upon for highly precise work, and the writer has found that better results will be obtained if a gage is made up as shown in Fig. 3.

This gage is made in three parts, screwed and (Continued on page 103)

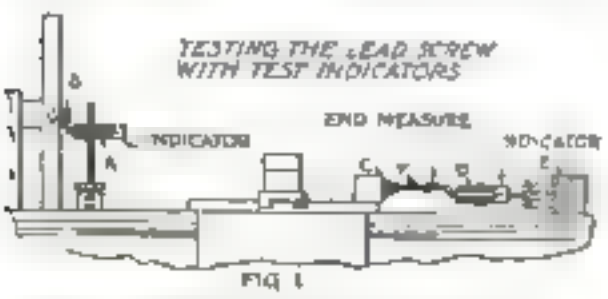


FIG. 1

The faceplate is turned several times and the movement of the carriage measured exactly

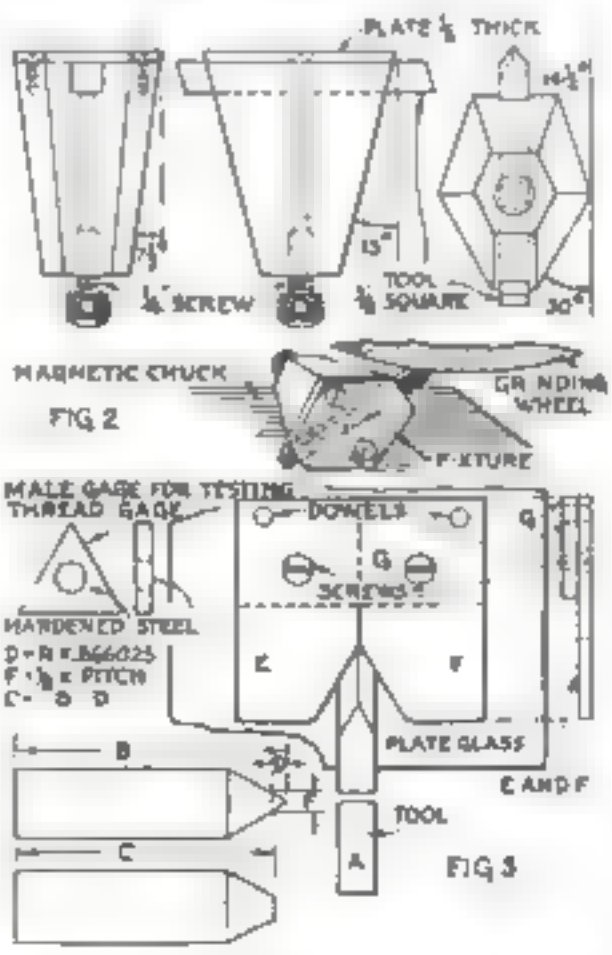


FIG. 2

FIG. 3

A fixture for grinding thread tools, a special gage, and a way to obtain the correct flat

MANY time-saving shop ideas are contained in the continuation of the Better Shop Methods Department, to be found on pages 102 to 107.

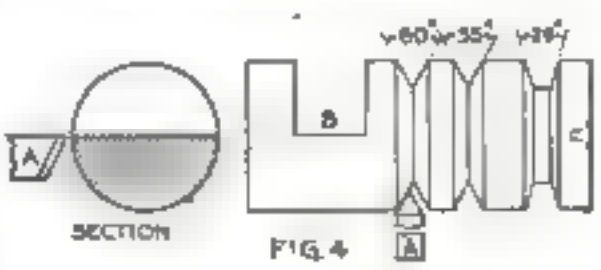
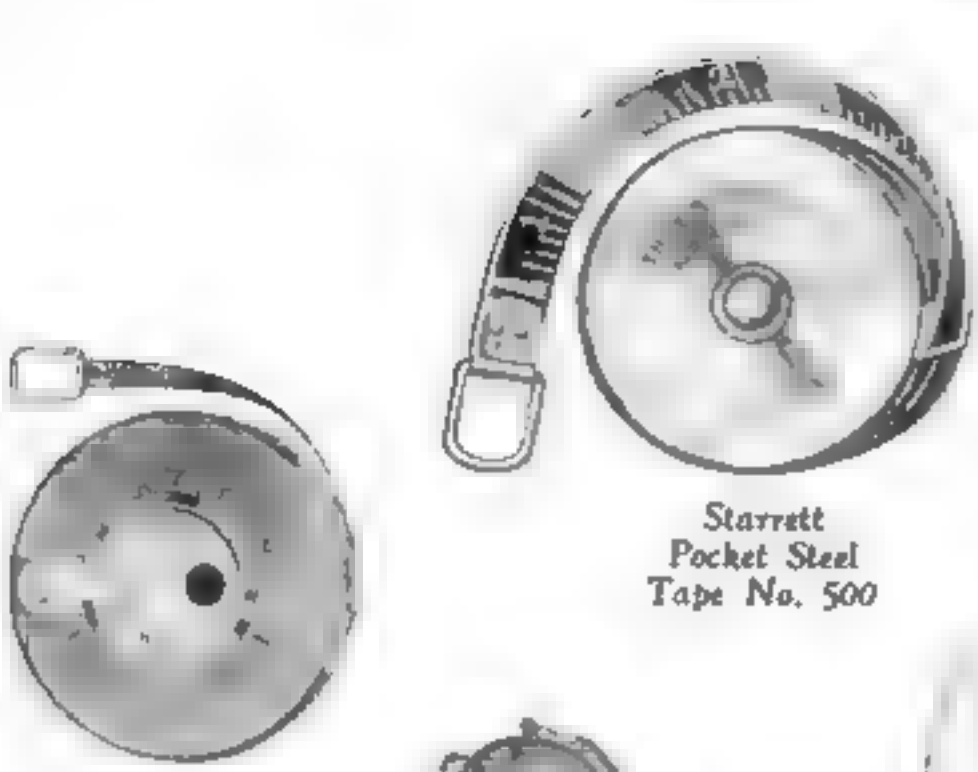


FIG. 4

A gage held between lathe centers for setting threading tools level and at correct height



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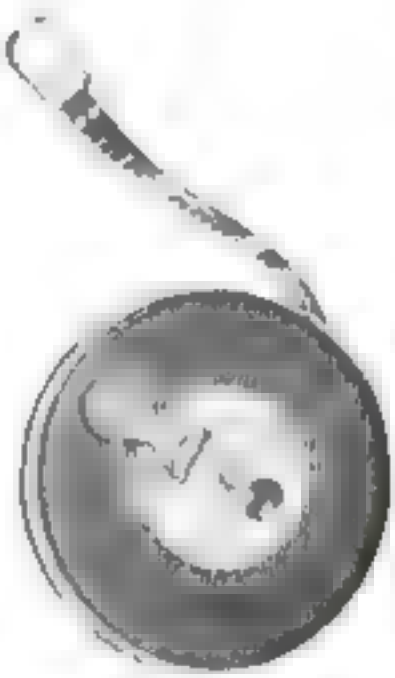

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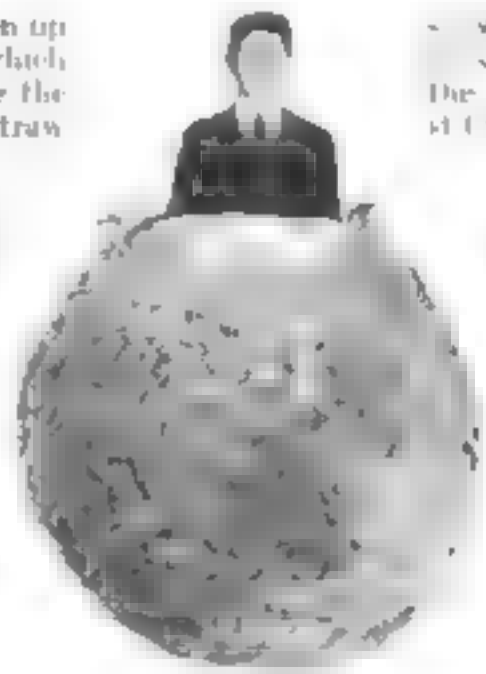
Archers Can Save Money by Making Their Own Targets

By A. Neely Hall

THOSE who have taken up the sport of archery, which is now so popular, realize the necessity for having a straw target. Yet a regulation tournament target, if purchased at a sporting goods store, costs at least $15, and the stand usually $5 or more extra. One can buy a serviceable bow and half a dozen arrows for less than that. To make a target, however, is relatively inexpensive.

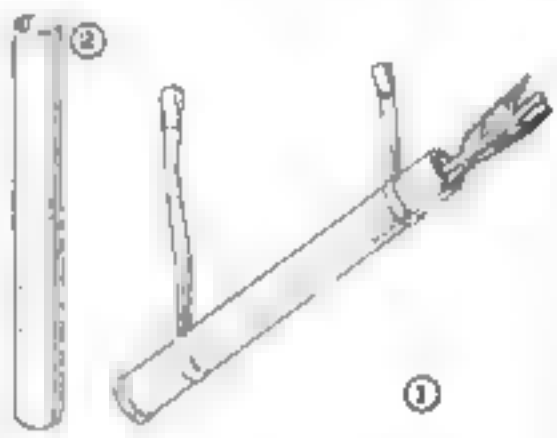


A homemade archery target made of rye straw sewn together as shown

Rye straw is better than wheat or oat straw but you must be governed by the straw that you can get. You will need, also, two large balls of strong wrapping twine and oilcloth for the front covering.

The standard tournament size is 4 ft. in diameter. The bull's-eye is 9½ in. in diameter and each of the concentric rings measures 4¾ in. across. You can make a smaller target if you wish, reducing the bull's-eye and width of rings proportionately. Oilcloth can be obtained 54 in. wide, which is just right for a 4-ft. target.

The first thing is to form a rope of straw 1 in. in diameter. Press the straw together compactly, and bind it every 6 in. or so with twine (Fig. 3). In splicing ends of straw, overlap them and bind with twine. Having made a rope 8 or 10 ft. long, roll it up into a flat spiral mat, as shown in Fig. 4. Each turn must be stitched securely to the preceding turn, and the stitching should be done with a large upholstering needle threaded with the wrapping twine. When the first length of rope has been fastened in place, make a second rope and add it to the first; then add a third and continue until the diameter measures a little more than 48 in. Go over the surface and reinforce the stitching at every point where there is an indication of its not being firm. The outside turn of rope should be stitched to the preceding turn with stitches not farther apart than 2 in.



How to make a quiver for target practice from a mailing tube and how to protect the left forearm with a wrapping of friction tape

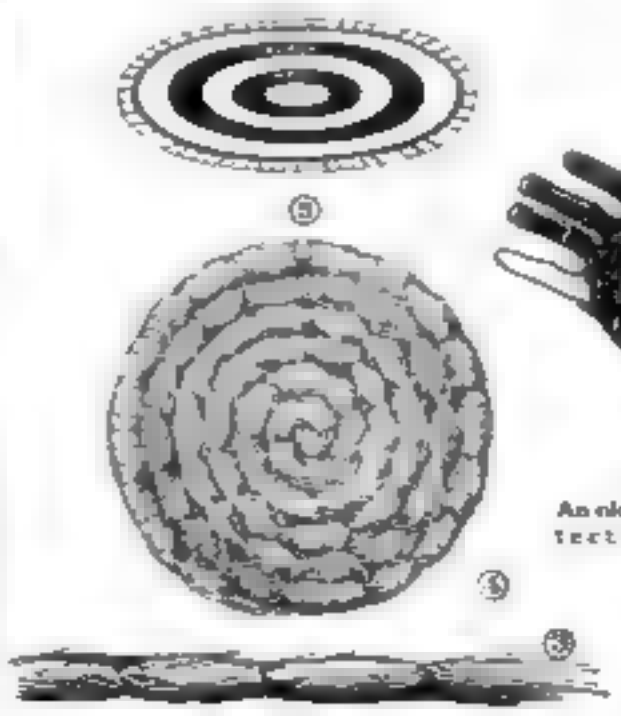
The target bull's-eye, or gold, and the four rings, are drawn most easily upon the oilcloth with a strip of cardboard having a pin near one end for a center, and holes punched at the correct distances from it for a pencil to stick through. Outside of the outer target ring is a narrow border (Fig. 5), known as the petticoat. It may be omitted.

Paint the gold with bronze radiator paint, or yellow paint. Use oil paint for the other rings. Fig. 5 indicates the colors to use and their correct order. To avoid runs, paint alternate rings one day, and the intermediate rings the next day.

An old glove will protect your fingers

Instead of trimming off the edge of the oilcloth on the outer line of the petticoat, leave a margin of 2 in. or so, slash this as indicated in Fig. 5, and turn it under to reinforce the edge. Spread the painted oilcloth over the mat and punch a row

(Continued on page 84)



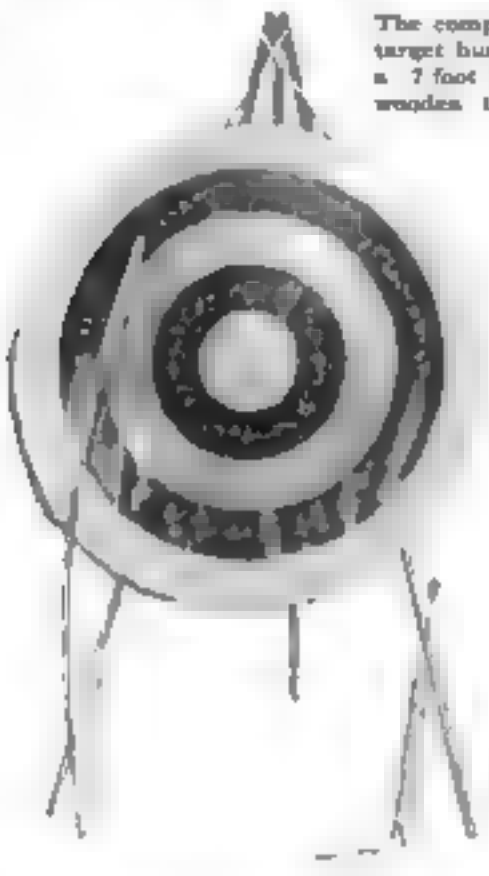
The straw rope is sewn to form a large flat coil and then covered with painted oilcloth

Archers Can Save Money

Continued from page 83

of holes 2 in. apart around the edge, inside of the petticoat band. With the upholstering needle threaded with wrapping twine, stitch the oilcloth to the mat.

Figure 6 shows a good target tripod made of three pieces of wood 1 by 2 in. by 7 ft. Its upper ends are bolted together in such a manner that the three legs can be folded as shown in Fig. 7



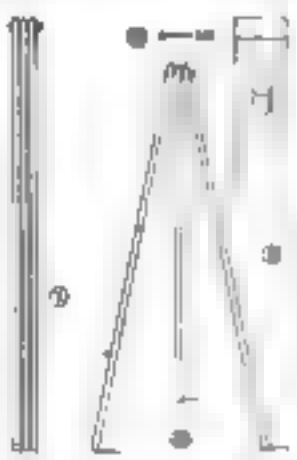
The completed target hung on a 7 foot high wooden tripod

This is made possible by slotted holes in the outer legs (Fig. 8). Use a ¾-in. bolt long enough to allow for the spreading of the legs, also two washers (Fig. 9).

The center of the target should be 4 ft. above the ground. You can fasten brackets to the target legs to rest the target on, but a better scheme is to attach the two ends of a rope to the back of the target, and hang the loop of the rope over the tripod top as shown in the photograph above.

A quiver for holding arrows (Fig. 1) can be made of a mailing tube (Fig. 2) with one end capped with a tin can cover. The cover can be fastened with friction tape. The best way to carry the quiver is to hang it from one's suspenders buttons.

Fasten pieces of tape around the mailing tube near the ends, and make loops in the tape ends, after cutting the tapes of the right lengths to hold the quiver in the position shown in Fig. 1



How the three legged target stand is made

The simplest protection for the left forearm, against which the bowstring strikes in a loose wrapping of friction tape. The fingers of the right hand also should be protected and a glove with the thumb and little finger removed, and the three remaining finger tips cut off, serves excellently

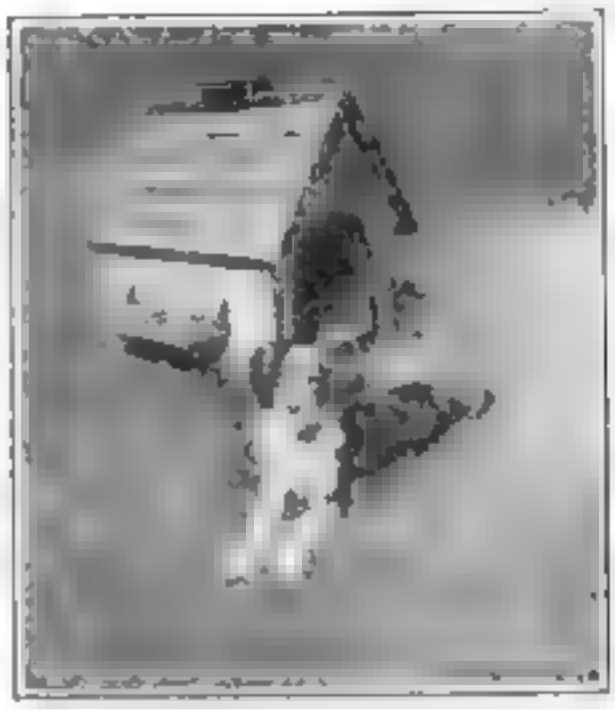
A Real Home for Your Dog

By Wilson G. Walters

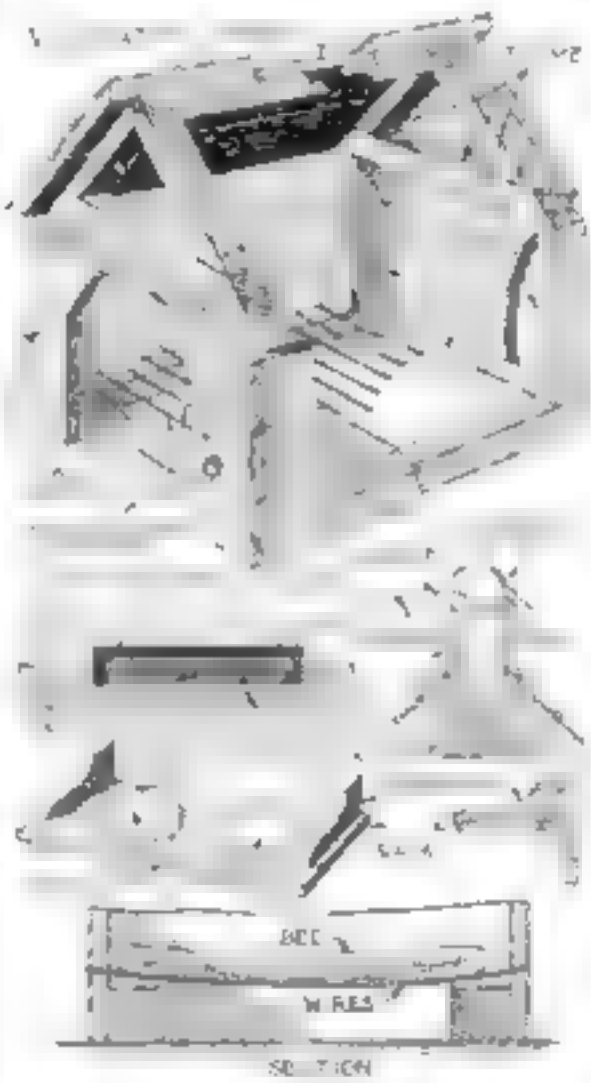
MANY a dog is left to his own initiative to find a comfortable spot in which to eat and sleep, either in the garage, on the back porch, or in some open place. Yet he imagines, no doubt, he is a member of the family, and often we think so, too. Then why shouldn't he have a comfortable place of his own?

When I designed a house for my dog, I took these ideas into consideration and included three features, a soft bed supported well above the ground on wires, a ventilator, and a dish rack.

The framework was constructed as



The three main features of this dog house are a soft bed, a ventilator, and a dish rack



How the house is put together and views showing provisions for the dog's comfort

shown. For the ventilator opening, I cut a piece from the main roof beam and fastened two small strips in suitable notches, as shown. The ventilator proper was made from thin wood with a tin roof supported by four nails, the heads of which were beat over and soldered to the tin, as indicated in one of the details.

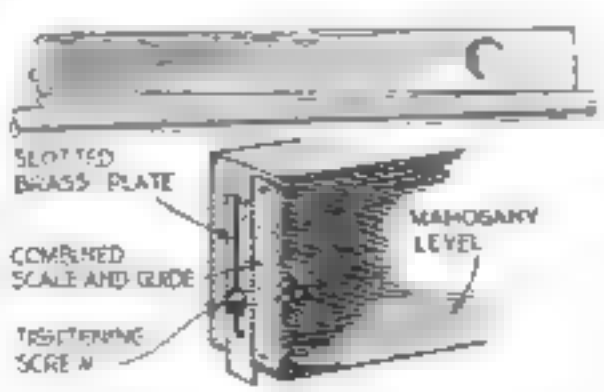
A heavy wire was wound in and out through a row of holes near the bottom in each side wall and pulled taut so that it will stand considerable weight without sagging. On top of this I laid several layers of canvas from an old awning to keep out any dampness and then added old rugs and blankets to make a soft bed extending from wall to wall. The bedding is removed at intervals for airing and a hose is turned on the house.

The dish rack is simply a board with holes to receive the dishes. It is attached by means of brackets to the wall at a convenient height.

In the winter a door that swings inward and outward can be attached, or if the dog spends most of his time indoors during cold weather, the house may be placed in the cellar.

Adapting a Carpenter's Level for Testing Inclines

BY ADDING a slotted brass plate and a short scale to one end of a carpenter's level, as shown, it is possible to use the level for laying out inclined



An adjustable brass plate at the end of the level allows inclined work to be laid out

work of any kind. This is especially useful in connection with laying pipe.

Another type, in which the scale itself slides up and down, is sometimes used and can be obtained at many of the larger hardware stores. J. D. G.

Hiding Defects in Woodwork

SMALL defects in furniture and other finished woodwork can be filled and concealed with sealing wax. Stationers and art stores carry sealing wax in a great many different colors and it is usually possible to find one that will match the woodwork to be repaired. Better still are the regular furniture finishers' shellac sticks, which are sold in the larger paint stores. There is also now on the market an especially useful type of uncolored plastic wood filler that resembles wood itself when hard.

Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

VARIOUS varnishes may be used for glass, but each one has certain limitations that restrict it to certain definite purposes.

A varnish to imitate the ground glass of a photographic camera consists of ¼ teaspoon of gum sandarac and ½ teaspoon of gum mastic in a mixed solution of ½ glass ether and ¼ glass benzol.

Because of the unequal evaporation of the solvents of this peculiar mixture, one of the gums, which is less soluble in the remaining mixed solution, is deposited on the glass as a precipitate perfectly white

Painting an electric lamp with a varnish of shellac, sandarac, alcohol and ozonized turpentine, tinted with alcohol soluble dye

in character and having the appearance of ground glass.

Various alcohol soluble dyes may be added to this varnish if colored effects are to be obtained. A few drops of alcohol are used to make a concentrated solution of the dye and these drops may then be added to the varnish.

A word about dyes. If you have no dyes at hand and have no facilities for making them in your own laboratory, obtain some transparent water color stamps in any photographic supply store. An alcoholic dye solution made with these will result in brilliant tints.

For coloring electric lamps a different type of varnish must be used, but the dye solutions just described can be employed for coloring the varnish. The varnish consists of 2 oz. alcohol to which is added ¼ teaspoon mastic (or ozonized turpentine, which is soluble in the alcohol. In place of the ozonized turpentine, half the quantity of Venice turpentine may be used. In this solution dissolve ¼ teaspoon flake shellac and 1 heaped teaspoon sandarac. It is possible to reverse the quantities of shellac and sandarac. This gives a clear varnish. Add dye to color to the desired shade.

On the larger bulbs it is best to apply the varnish with a brush, as less varnish needs to be prepared. Smaller toy bulbs and bulbs for the Christmas tree are dipped bodily into the varnish and hung up to dry. This can be done by winding wire around the base of each lamp.

A black varnish for glass is obtained by dissolving asphaltum in benzol.

How to Do Wrought Ironwork

With Very Few Tools, You Can Make Decorative Hardware and Furniture from Cold Metal

By T. M. Bridges

TO THE average person who boasts a home workshop, the expression "wrought iron" conjures up visions of a huge anvil, hammers, a large, long- armed blacksmith's shop. However a large number of really useful and artistic things can be made of iron worked cold. With a good vise, ball-peen hammer, files, hack saw, cold chisel, center punch, drill, rivets, a few lengths of iron of various widths and thicknesses, and ordinary intelligence, one can work wonders.

Hammered hinges like this one are not hard to make

What is known to the trade as "sword-stock iron" may be readily worked cold. It can be bent, twisted and shaped almost as easily as copper. Wherever pieces are to be fastened together rivets are used, as no heating or welding is done.

A few of the things that can be made at very little expense this way are hinges, drawer pulls, straps and escutcheons for treasure chests, fireplace sets, foot scrapers, knockers, magazine racks, wall brackets, stands for bird cages, smoking stands, and bridge and table lamps.

The hinge illustrated is one of a set of six made for a highboy of antique design. To make a set of similar hinges, buy a piece of soft sheet iron of the right thickness, which is determined largely by the size of the hinge and its required strength. Stock 3/32 in. thick was used for the 8 in. long h[illegible]

After having made [illegible] of the hinge, transfer the design of the butt and strap to the iron separately, using for this purpose yellow carbon paper.

Next lay out the knuckles or joints, allowing for the length of the knuckles about two and a half times the diameter you wish to make the joint. To insure maximum strength, the total width of the knuckles of the strap should be approximately equal to the total width of those of the butt.

Before starting to cut out the hinge, go over the design carefully with a hardened steel scribe, making marks that will not rub off in handling. The scribe can be hardened by heating about 1 in. of the point and sticking it in sealing wax.

Fasten the metal in the vise with the marks or outline to be cut about 1/64 in. below the top of the jaws. Use chisel and hammer as shown, so that the chisel will act as a powerful shear. The cleanness of the cutting depends largely upon the sharpness of the chisel and the condition of the vise jaws.

You will not, of course, be able to follow the entire outline of an intricate design with the chisel, but by practicing a little and shifting the position of the metal in the vise, you will find you can cut around so as to leave very little work for the files.

In cutting around the knuckles use the hack saw and chisel for the rough work and true up with the files.

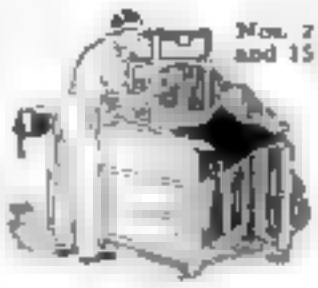
When you have done your best to make the outlines smooth and perfect, hammer the entire surface with the exception of the knuckles, using the ball end of the hammer. Then, with the flat face, go around the cuts to edge to give a slightly beveled effect. Any smooth, flat metal object will serve for a hammer.

After the hammering, the hinge will be curled out of shape. To straighten, turn it face down on a smooth piece of wood and use the flat face of the hammer.

You are now ready to make the joint. Take a rod of the correct size for the pin, place it across the knuckles at the position it will occupy in the finished hinge, clamp in the vise with knuckles up, and then bend the knuckles around the rod as far as you can with the hammer. Remove from the vise and, keeping the rod in the same position, use the vise to pinch the metal snugly around the pin, and round up with the hammer.

When the knuckles have all been bent into the proper shape, remove the pin and assemble the strap, butt and pin. Drill holes for the screws and the hinge is finished. Round head iron screws look best on work of this kind. (Continued on page 88)

Blueprints for Your Home Workshop



ANY ONE of the blueprints listed below can be obtained for 25 cents. The blueprints are complete in themselves, but if you wish the corresponding back issue of the magazine, in which the project was described in detail, it can be had for 25 cents additional so long as copies are available. The editor will be glad to answer any specific questions relative to tools, material, or equipment.

POPULAR SCIENCE MONTHLY
250 Fourth Avenue, New York

GENTLEMEN:

Send me the blueprint, or blueprints, I have underlined below for which I enclose ..... dollars ..... cents.

No.	Title	Date of Issue	Price
1.	Sewing Table	Feb., '11	25c
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44.	Pirate Ship Model—Hull	Feb., '16	25c
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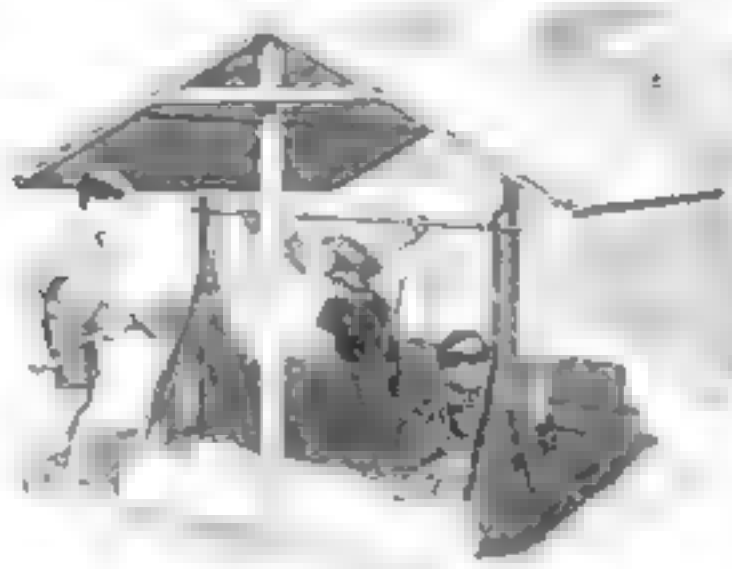


CHILDREN have endless fun playing on a swing-cover sandbox with its movable seats

Building a Sand-Box Play Shelter

By JOSEPH FALK

PLAYING in the sand never loses its fascination for small children. Give them a roomy sand box in a shady spot and they will amuse themselves endlessly.

To build a combination sand box and play shelter is a very simple task. A few two-by-fours and odds and ends of boards and an old tent fly, tarpaulin or awning are the only materials needed. As no fixed dimensions or methods of construction have to be followed the builder can easily adapt the design to suit whatever materials are at hand. Two types of play shelters are illustrated and either can be modified or elaborated in many ways.

The shelter shown above consists of a large sand box with two posts, which support a framework of 1 by 2 in. strips covered with canvas.

Two removable standards, which fit over the sides of the box, support a length of pipe. This will serve as a safe horizontal bar, but its main purpose is to carry a simply made swinging seat. The standards and seat can be stood up handily and placed outside the sand box, when in use.

Another low seat, a trifle wider than the box, is made with cleats under each end so that it can slide back and forth on the edges of the box. This is for the children to sit on, if they wish, while playing with the sand.

The other shelter illustrated is more like a conventional arbor. Half of the roof is supported by a sand box and the other half by a seat.

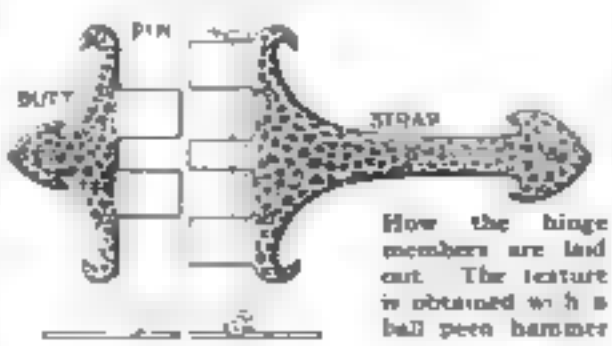
No matter what construction is used in building a sand box it should be given two coats of paint, either dark green or a color to harmonize with the near-by house.

It is important to have clean white beach sand for the boxes. When this cannot be obtained locally a few bags can be bought from a dealer in masons' supplies.

A play shelter that can be made quickly and cheaply from odds and ends of lumber

How to Do Wrought Ironwork

(Continued from page 86)



How the hinge members are laid out. The texture is obtained with a ball peen hammer

Where iron is given a hammered finish, a good effect may be obtained by going over the surface with a piece of emery cloth to bring out the high lights. If the natural iron color is desired, the finished article should be either waxed or oiled to prevent rusting. Bronzes can be used to advantage in giving finishes of various colors and combinations.

WHEN STICK shellac, such as is used by furniture makers, cannot be obtained for filling cracks and holes in woodwork, a cement may be prepared by melting equal parts of crushed rosin and beeswax and adding a small quantity of flake shellac. This is poured into a waxed cardboard form and allowed to harden. It is melted into holes and blemishes with a hot knife. A sufficient quantity must be used to allow for shrinkage in cooling, then any surplus is cut off with a knife or chisel that has been dipped in water. In its natural state, this cement matches pine, birch and other light woods. For dark woods, it should be colored while hot with Venetian red (powder) for mahogany and Vandyke brown for walnut.

The Shipshape Home

Patching a Shingled Roof

To REPAIR wooden shingled roofs, I use slips cut from single-ply asphalt roofing. These are long enough to reach from the butt of the shingle up to the first row of nails. I lift the shingle up just far enough to allow a slip to be pushed in place. The sun melts the asphaltum sufficiently to stick the slip in place. No nails are needed.

When a roof has to be patched, I unroll the roofing on a floor or other level place and brush it well on both sides with a broom to prepare the surfaces so that they will stick readily. Then, with a pair of compasses, a straightedge, and a sharp scratch awl, I divide the roofing into

Leaks are stopped by sloping patches cut from asphalt roofing beneath the shingles

rectangles 9 by 5 or 3 by 6 in. These practically fall apart after being scratched, but, of course, tinner's snips could be used to cut them apart, if preferred.

As an example of the saving which can be made by this method of patching, I put $500 of these slip shingles last fall on a farmhouse with 15 squares of old shingle roofing. This cost $3.75 for three rolls of one-ply roofing and six hours' time, whereas to have had the roof shingled would have cost more than $200.

There is one further advantage: To patch an old roof with new shingles here and there gives it a spotted, unsightly appearance. The slip shingles, on the other hand, cannot be seen at all.—JOHN R. DODGE.

Stopping a Water Leak

WHEN a water pipe is leaking and it is impossible to make a permanent repair immediately, the flow of water may be stopped by cutting from an ordinary hose a piece of rubber tubing about 2½ in. long, slitting it down the center, and slipping it over the pipe. Fasten it in place over the leak with a common C-clamp, a nut and screw or any other clamping device.—E. C. BONNER.

A temporary repair

TO MAKE an inexpensive liquid metal polish, mix one part melted paraffin and seven parts gasoline, and add two parts FF pumice stone or whiting.

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The SHIPSHAPE HOME

How to Prevent or Overcome Difficulties That May Arise When You Paint Your House

FOLLOWING Berton Elliot's recent articles on painting troubles and their remedies in POPULAR SCIENCE MONTHLY, many letters were received from readers who had experienced difficulties other than those mentioned. These letters indicate that keener interest is felt in how to remedy unsatisfactory conditions when repainting a house than, perhaps, in any other phase of painting. Mr. Elliot's answers to some of the questions that were asked repeatedly should be of value to all who undertake their own home painting and decorating.

Among the troublesome conditions in exterior painting mentioned by readers were the following:

The paint on my house washes off like milk in a good rain. Will you please tell me what to do when I repaint?

PROBABLY some surface condition was not suitable to paint over, or else moisture gets under the paint and keeps it soft. If the condition is prevalent only in certain places, or on one side of the house, it may be that a leaking or overflowing eaves trough or down spout has kept the paint soft.

As to the remedy, the house should be thoroughly scraped to remove all loose paint or scales. You must be sure that the surface is thoroughly dry, not only on the surface, but all the way through, at the time of repainting.

The first coat of paint should be one part raw linseed oil, one part turpentine, one part paint. The second and third coats should also carry a liberal amount of oil and turpentine, in the proportion of about one part oil, one part turpentine and six parts paint. All the coats should be brushed out thin and brushed in well. This is important.

The last coat of paint on our house has chalked so badly that it is unfit for repainting. You can blow the chalky powder off, and when you draw your hand across it, it is covered with powder. What is the best thing to do?

YOU must get the chalky deposits off before repainting. There is no better way than to scrub the surface with warm water and a good gritty cleansing preparation. It is really not so big a job as it seems. One can start in on a Saturday morning and be pretty well around an average sized house before night. After scrubbing, turn the hose on the surface.

Another method often used is to go over the surface with a wire brush. This is usually satisfactory, but not so thorough as the other way.

The chalking may have been due to too little oil in the paint to satisfy the absorption demands of the surface, so be sure to have a generous amount of oil and some turpentine in the paint the next time you paint.

The east side of our house, fully exposed to sun and weather, stood up very well after painting last time, but on the south side, especially in the shadow of the eaves, it peeled and blistered badly. I would be pleased to receive any suggestions as to the method of dealing with this problem.

AS YOUR house was painted with the same paint on all sides, and no doubt by the same painter, the results should have been the same on all sides, providing the condition of the surface was the same. So it seems that the surface under the eaves must have been wet through when painted, or painted early in the morning before the dew or moisture had a chance to evaporate, or else rain has gotten in under the paint in some way, possibly from the eaves. This is liable to cause blistering and peeling, especially if the sun strikes the surface during part of the day, drawing out the moisture and causing the paint film to break loose from the surface.

(Continued on page 91)

LETTERS from readers indicate that house painting difficulties are quite common. As a last resort it is always possible to have a painter burn off any paint that has blistered and peeled badly. This drastic but effective cure is one the amateur rarely undertakes himself because of the experience it requires and the great fire hazard. Other methods often will serve as well, and these are outlined by Berton Elliot in the accompanying article

The Shipshape Home

(Continued from page 110)

in places and puff up into blisters. In some cases moisture keeps the paint soft instead of blistering it, this being more generally the case where the hot sun does not strike the surface and the wet condition keeps up continuously.

When you repaint, the following procedure should insure good results, providing the surface is absolutely dry at the time of painting.

Scrape off all loose scales and peelings. Tap the surface with a wood mallet to jar loose any peelings that are ready to let go. Break any blisters that have not opened up with a putty knife and scrape off the loose film as far back as it will go. Do this work carefully and thoroughly.

Coat over all the scaled surfaces with equal parts high grade outside house paint or white lead and oil, reduced with an equal part of raw linseed oil. Allow this paint to dry for three or four days at least, longer if the weather is very damp. Then apply one or more coats of high grade house paint or lead and oil, properly mixed.

Our house was painted a good many years ago with Indian red, which turned dark, almost black, in spots. We then repainted with white paint, but this cracks when applied and blisters, showing much of the red paint—and does this every time we paint.

THE nature of Indian red is such that it very generally turns dark in an irregular and unsightly manner. Being very oily, paint coatings applied over it in the regular way are liable to crawl when applied. This is also the case with various other painting materials of a greasy nature.

Wipe over all places where the last coatings have crawled and the red shows through with a cloth saturated with a liberal quantity of turpentine. This will tend to cut the greasiness of the surface; it is one of the best remedies to try wherever paint crawls from any cause.

After the turpentine has evaporated, coat over the places where the red has been showing through with a mixture in the proportion of ½ gal. paint, 3 pts. turpentine and 1 pt. raw linseed oil. Allow to dry for three or four days, or longer if the weather is damp, then apply one or two coats of prepared house paint or lead and oil paint in the regular manner. It is especially necessary where trouble of this sort has been encountered to be sure that the surface is thoroughly dry and the weather dry and bright.

Please tell me if it is advisable to use a paint remover on the outside of buildings to take off old paint coatings.

PAINT removers are not practical for outside work. The objection is that after the work is done it is difficult to clean off the paint remover thoroughly with any degree of rapidity and at a reasonable expense. If the paint remover is not entirely removed, it will act on the new paint and prevent it from drying.

Rebuilding a Transmission

It Isn't Such a Big Job If You Do It Yourself, You Can Look After Many Small Details a Garage Man Might Ignore

By Ray F. Kuns

CAR owners who take pleasure and pride in doing their own repairing will find that the rebuilding of a transmission is a job they can undertake successfully without assistance.

If the propeller shaft is of the type that can be dropped down and the transmission then dropped from the flywheel housing, the task is not a hard one. On the other hand, if the propeller shaft is inclosed, it will be necessary to release the springs at the rear axle and move it back to get at the transmission.

After the transmission has been dropped down and pulled from the car it must be cleaned thoroughly. Start with hot water and finish with a putty knife, kerosene, and a stiff bristle brush of the paint brush type. Half the joy of doing your own repair work is knowing that a thing is clean.

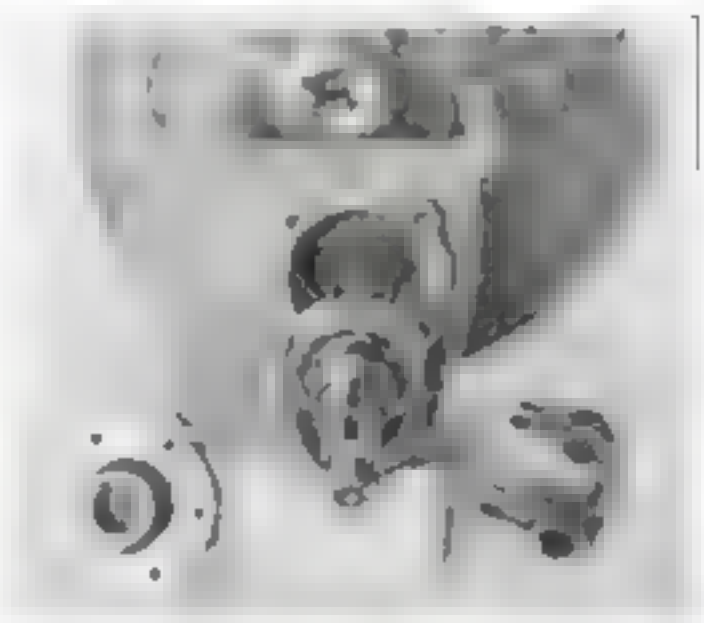


Fig. 1 (at left). First remove the cover plate and gear shift lever then nut A and screws B, holding the bearing mounting flange. Fig. 2 (above). After the flange is off, the transmission main shaft itself is pulled

NOW start the real operation by draining the oil from the transmission. Remove the cover plate and gear shift lever as shown in Fig. 1. Next remove the cotter key and nut A and pull the flange. Take out the screws B, which hold the main transmission bearing mounting flange. The transmission shaft will come out of the transmission through the hole left by the ball bearing, leaving the sliding gears to be lifted out at the top of the transmission case.

Now start work on the other end of the case and remove the screws which hold the mounting flange and

Fig. 3. Remove the flange and bearing supporting the clutch shaft A, and the idler gear cover B and pull pin C

bearing that supports the clutch shaft. This shaft is marked A in Fig. 3. The next step is to pull the plate C, Fig. 1, also remove the idler gear cover shown at B, Fig. 3. Next pull the pin marked C, Fig. 3. The short idler gear shaft then may be removed and the idler gear pulled.

THE countershaft bearing A, Fig. 4, is lifted out and the countershaft front bearing also is removed. Finally, the countershaft marked B, Fig. 4, is moved endways to free it and turned and lifted upward and out of the top of the case.

All the parts should be cleaned carefully and inspected. Examine the clutch shaft A, Fig. 5, to learn what condition it is in. The point most likely to suffer damage is the gear rod, which must take the bearing marked F, on the forward end of the transmission shaft C. A roller bearing is used in this case. Sometimes the rollers are worn or crushed and the races worn. If that is the case, they should be replaced. Plain bronze bushings are used for bearings at this point very frequently. These are subject to great wear and should be replaced when the transmission is down. When this little bearing is worn, the transmission gears separate and make much noise on a pull because they are not properly meshed and also because the shafts are out of line.

Continued on page 164

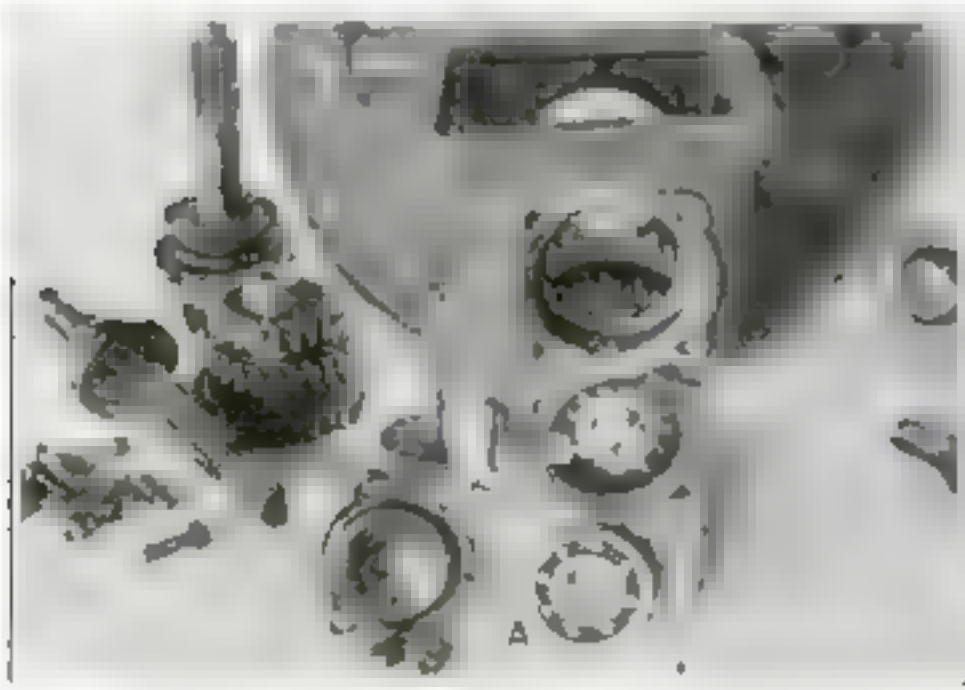


Fig. 4. The disassembling is continued by pulling the countershaft bearing A, moving the countershaft B endways to free it, and lifting it out from above

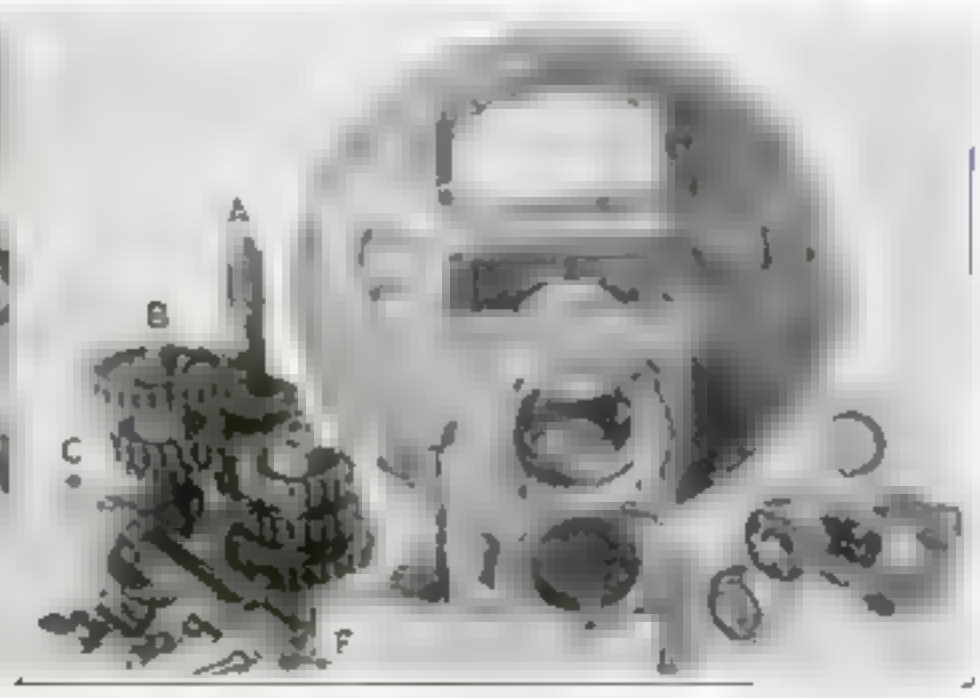


Fig. 5. The transmission completely disassembled. Examine for wear clutch shaft A, bearing F, sliding gears G and H, and countershaft gears B

Rebuilding a Transmission

(Continued from page 92)

The idler gear D, Fig. 5, is not likely to be damaged. It is used only in reverse, although it turns at all times; the bushing, however, may be worn. The sliding gears G and H are more apt to be damaged. If the teeth are worn tapered or if they are a loose fit on the shaft, it may be best to replace them. Certainly they should be replaced if they have nicks or parts broken out, or if they are badly pitted

Sometimes the gears on the countershaft B are badly worn. If they are, they will need to be pressed off and new ones pressed on.

In reassembling, the process is reversed. Pack all bearings (E and F, Fig. 5) with clean cup grease and see that new gaskets are used. End play of the shafts is usually taken up by means of shims. Add the proper amount of transmission grease when the job is finally replaced in the car and everything has been checked for proper assembly.

The owner will usually take time to see that all parts he has removed are carefully cleaned and lubricated. In any job as large as this, many parts must be removed which have no real connection with the transmission overhaul. The garage man ordinarily could not see that all these were given the greatest care as the time required might be more than you would think the job ought to cost. When you do this work yourself, however, you can look after these little details.

Bench Vise Aids in Clamping Awkward Glued-up Work

The hull of the POPULAR SCIENCE MONTHLY galleon clamped by vise while glue is drying

WHEN hand screws or clamps are not available for gluing up such objects as ship hulls and small frames, a bench vise can be made use of, as illustrated. Various sizes can be taken care of by using blocks between the work and the tool rack at the back of the bench.—R. W.

THE amateur mechanic often finds himself at a loss when he wishes to make a hole through a flat steel spring. Make a dent in the spring with a punch and carefully grind off the projection on an emery wheel. This will leave a smooth hole.—ARTHUR ALLEN.

How to Make a Paneled Chest

A Finely Proportioned and Decorative Storage Box, Enriched with Stock Moldings—May Be of Cedar, Birch, Walnut or Other Woods

By Herman Hjorth

Author of "Reproduction of Antique Furniture"

AMATEUR woodworkers rarely make as much use as they might of the many varieties of molding to be obtained at lumber yards and mills.

It is true that the moldings generally are of woods such as pine, cypress, whitewood and chestnut, rather than the finer cabinet woods, but they will serve the home worker if he is in the habit of using inexpensive woods and staining them mahogany or walnut, or if, as is more frequently the case, he is making furniture that is to be painted.

When it is essential to have moldings in a fine cabinet wood, a good plan is to select some suitable patterns from the lumber company's stock and ask that a few feet of the molding be cut from the desired number some time when the molding machine knives are "set up" for the purpose. Any amateur craftsman, too, can make his own moldings if he invests in a universal plane or buys suitable wooden molding planes.

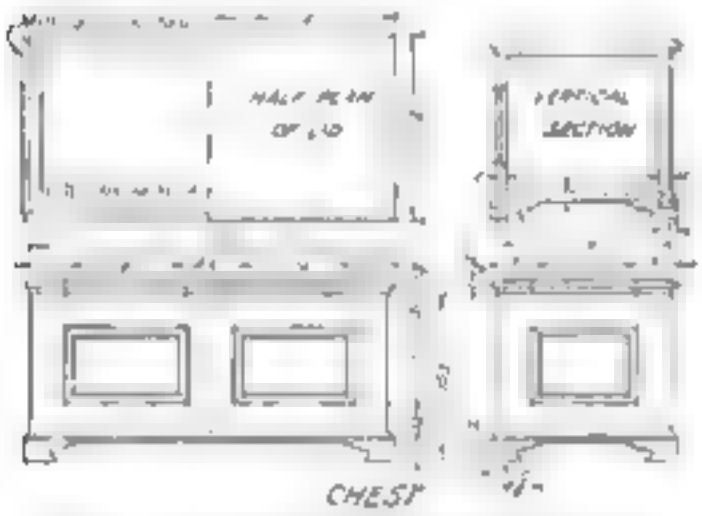


Fig. 1. Front, end, plan and sectional views. The dimensions can be varied to suit the builder

The chest, Figs. 1 and 2, is an example of the use of stock moldings. It need not necessarily be made of cedar, any suitable cabinet wood may be used.

The method of construction recommended is as follows: Make the front and ends as shown in Fig. 7, with panels inserted either as at A or B, Fig. 4. The first requires more accurate fitting but has the advantage of forming a smooth inside surface. The bottom and back may be made of some cheaper lumber. The bottom is grooved as shown in Fig. 8, or merely into the front and sides, in which case it can be slipped in from the rear, under the back. See alternative figures in list of materials.

The front and sides may be joined in the same way as the back and sides (see Fig. 6) or by a miter joint as shown in the plan view, Fig. 2. The latter method is the neater but is not quite as strong. The miter joint should be reinforced by dowels or a spline and a triangular block glued to the inside.

The feet consist of four pairs of blocks shaped as shown and inlaid at the corners. They may be fastened to the underside of the chest with glue and screws.

After the chest is smoothed and sanded, the panel and base moldings are cut to size in a miter box and glued in place. Fine brads may be used to hold the molding in place until the glue has set. Any surplus glue should be washed off immediately with hot water. The brads should be driven in in such a way that they can be removed easily when the glue is dry.

The lid or cover is glued up of plain boards, and, after it has been squared to dimensions, a simple molding is planed on its edges. If a molding plane is not available, a shallow rabbet may be planed with a rabbet plane and the edge then rounded with chisel, spokeshave, scraper and sandpaper. A frame, as shown in the detail drawing, Fig. 5, is made and screwed to the underside of the lid. This gives it stiffness and prevents warping. A cove molding is glued around the outside edges of the frame (see Fig. 2).

The lid may be hinged with a piano or continuous hinge, chest hinges or plain butt hinges. A rather large pierced brass or wrought iron key plate may be used around the keyhole of the lock. Hand wrought iron hinges across the lid also may be a desirable feature of decoration. A tray something on the style of a trunk tray, may be added, if desired.

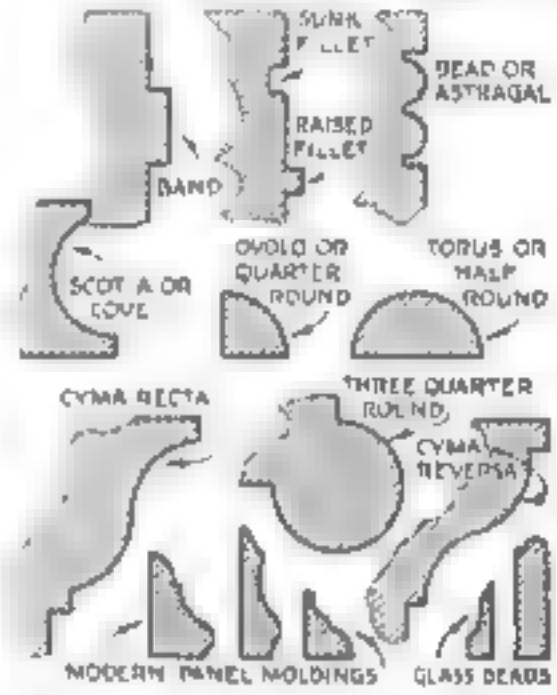


Fig. 3. Basic architectural moldings and several of the modern variations stocked by lumber dealers everywhere

Fig. 4. Two ways of inserting panels

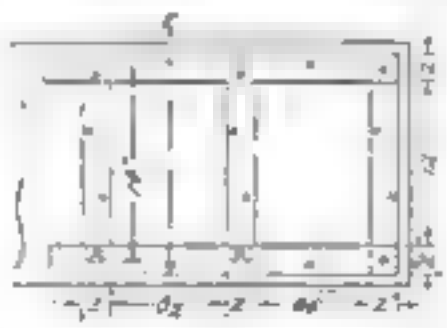
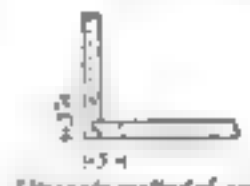


Fig. 5. Detail of frame which is screwed to the underside of the lid



Alternate method of joining front and side of chest

Fig. 6. One construction for the joints at corners

The materials needed are as follows: For front, 1 pc. 1 by 8 by 20 in., 1 pc. 1 by 3½ by 20 in., 1 pc. 1 by 4½ by 9 in., 2 pcs. 1 by 3 by 13½ in., for front panels. 2 pcs. ¾ by 7¾ by 12 in., for sides, 4 pcs. 1 by 3 by 13½ in. 2 pcs. 1 by 3 by 12 in. 2 pcs. 1 by 3½ by 12 in. for side panels, 2 pcs. ½ by 7¾ by 10¾ in. for back, 1 pc. 1 by 13¼ (or 12½) by 32 in., for bottom, 1 pc. 1 by 15 (or 13½) by 32 in. for lid, 1 pc. ¾ by 17½ by 34½ in., 2 pcs. ¾ by 2 by 33 in., 2 pcs. ¾ by 2 by 14 in. 2 pcs. ¾ by 2 by 16 in., for feet, 8 pcs. 2 by 2 by 4¾ in. cove molding, 10 ft. of ¾ in., panel molding, 10 ft. of 1 in. wide and 10 ft. of ½ in. wide; 3 butt hinges ¾ by 2 in. wide, chest lock and key plate.

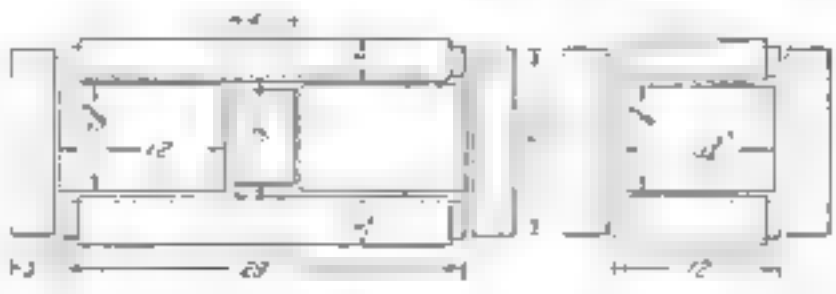


Fig. 7. How the front and ends are assembled. Dowel joints may be used, if preferred, in place of mortises and tenons shown

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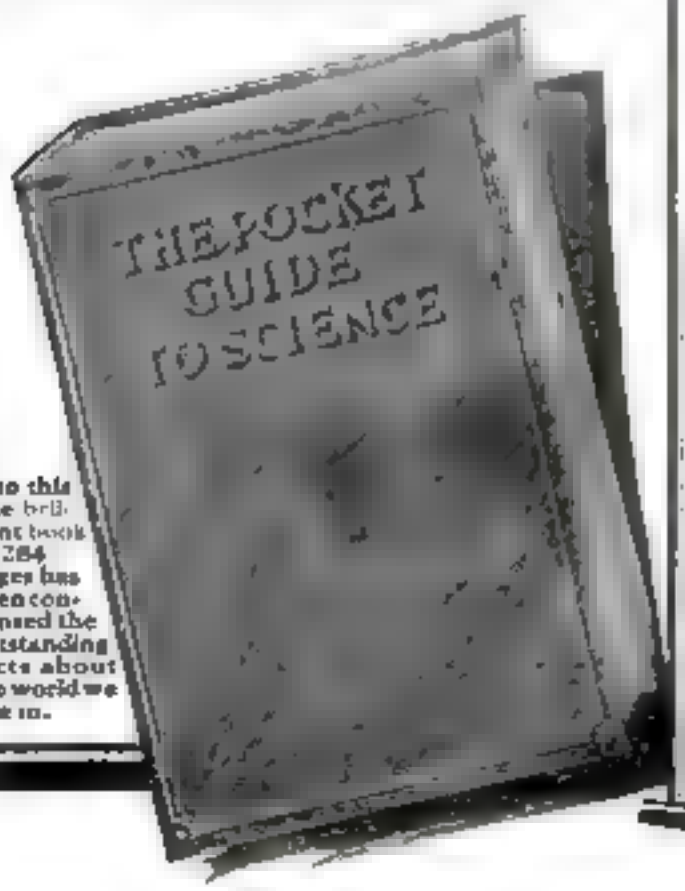

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   How was petroleum formed?
6. Do electrons really move through a wire when an electric current is flowing through it?
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9. Can we see atoms with a microscope
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14. Why is frost more likely on a clear night than on a cloudy one?
15. Does thinking use up the thinker's energy?
16. Which travels faster, electricity or light?
17. What simple test will distinguish wool from cotton?
18. What makes the noise of thunder?
19. Why would men ultimately suffocate if all the green plants were killed?
20. Does the boiling of water remove the impurities in it?
21. How do the living cells of the body get the energy with which to do their work?
22. How is the speed of light measured?

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A Ship-Model Weather Vane

(Continued from page 7)

bowsprit enters it is curved in one direction only, it is straight from side to side.

Scratch in the horizontal and vertical lines of the gun ports and in the middle of each port bore a ⅛-in. hole. Those in the middle may go right through, but the end ones, two forward and two aft on either side, should be bored to point forward and aft respectively. The guns, made from ⅛-in. dowel stick, project ⅜ in.

THE catheads are hardwood, a full ⅜ in. square by 1¾ in. long, the inner ends cut to a bevel to meet on the hull, to which they are firmly nailed to project forward and slightly upward. Across the stern nail a piece rather smaller and 2½ in. long, for the bumpkins.

The headboards may be wood, steamed so that it can be bent, but are more easily made from thin sheet copper, or they may be omitted entirely.

Find the center of balance of the hull and ¼ in. abaft this bore a hole vertically through it of a size to take a piece of your larger tube, as described later, and insert the tube to project barely above and below the hull.

Regarding the nails and other materials, it is advisable to use brass and copper only. You will need a dozen or so light, and thirty heavy ⅜-in. escutcheon pins, or brass nails.

In the description of the rigging to follow it is impossible to avoid the use of a few common nautical names. If you are in any doubt as to their meaning, you will find them explained in any unabridged dictionary or encyclopedia, usually with diagrams.

Bore ⅛-in. holes for bowsprit and masts at the positions and angles shown.

Just abaft the mast positions, glue and nail on the channels for the rigging. They are strips of wood ⅛ by ¼ by 2½ in. with seven notches ⅜ in. apart.

The foremast is a ⅛-in. dowel stick 17 in. long, tapered to about one half that diameter at the top. The mainmast is similar, but 18⅛ in. long, and the bowsprit is the same thickness and 11 in. long. These lengths do not include the part to be inserted in the hull, which should be about 1½ in.

The fore yards are 4⅛, 6, 7½ and 10 in. long and ⅜, ⅛, ⅛ and ⅛ in. in diameter respectively at their centers. They taper to a point at the ends.

The main yards are 5¼, 7¼, 8½ and 11 in. long of the same diameters as the foremast yards. The driver boom is 9 in. long, the gaff, 8½ in., and the upper gaff, 3 in. long. They are about the same thickness as the yards, but taper from the mast to the ends.

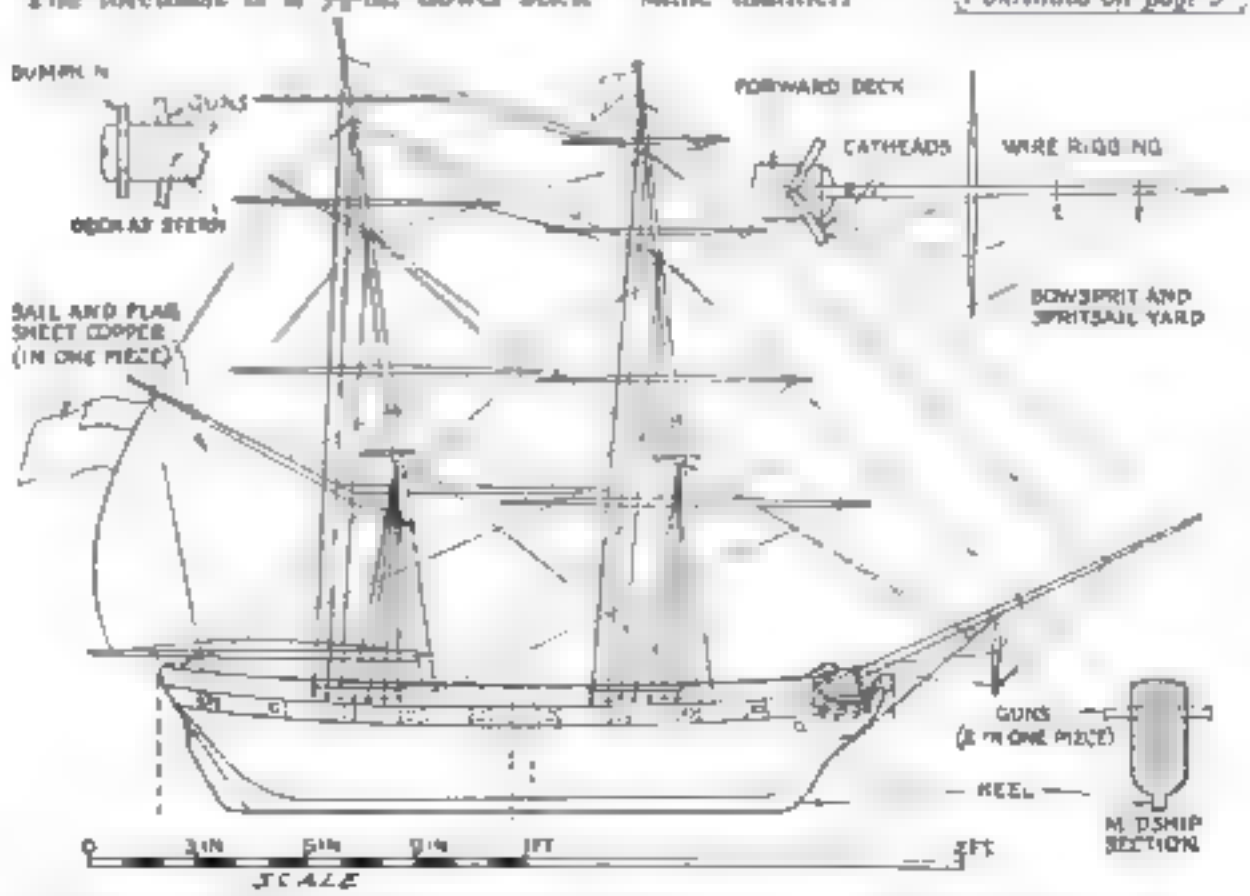
The spritsail yard is 7 in. long and the dolphin striker, 2¼ in.

The spars should be stained a dark brown and given a coat of good quality spar varnish.

THE tops, if desired, are cut from sheet copper as shown on Blueprint No. 68. The masts go through the center holes and are retained in position by nails through the mast underneath. The long slots are for the lower rigging to pass through and the holes are for the topmast rigging.

Step the masts and set up the shrouds and backstays, which are No. 18 copper wire. Make a loop in one end, and it to the hull just above the gun port, one pass the other end through the slot in the top of mast), carry around the mast and down again, fastening off in the same way. The topmast shrouds, if any, are twisted together at the masthead, pass through the holes at the edges of the tops, and through a hole in the mast at the level of the lower yards. The other backstays are twisted together abaft the mast and have their ends fastened off in the same manner.

(Continued on page 9)



Side view of the vane, a section through the hull, and details of bowsprit and guns. The yards are shown diagrammatically fore and aft; in the model they should be braced across the ship

Ship-Model Weather Vane

(Continued from page 96)

The topgallant and royal backstays should be of No. 22 wire

With a long nail or thin screw, fasten the dolphin striker to the bowsprit, insert the latter in its hole, and bind it down firmly with wire to a hole in the cutwater From where the former spar goes, set up a bobstay to a hole low down in the stem

The bowsprit shrouds come from the position of the royal and topgallant stays, where they pass through the spar to the ends and halfway out on the spritsail boom and back to the catheads

Next set up the mainstays, as shown in the plan, and the forestays, the three outer ones of which pass through holes in the bowsprit. The two outer forestays

The hull is a single block of wood the masts are dowels, and sail and flags, sheet copper

are fastened to the end of the dolphin striker and from there go back to the catheads; the next one goes through it and back to a nail in the bowsprit.

The yards are bound to the masts and bowsprit with copper wire. The lifts and braces may be in one piece. Twist the middle of the wire to one masthead, then carry it through the yardarms with a twist, and back to the positions shown

The sail (driver or spanker) and flag are cut from a piece of thin sheet copper, along the edges of which small holes are punched It is bound with thin copper wire to the gaff, mast and boom. These spars can then be fastened to the mast with thick copper wire. Pass it through the spar and around the mast and clinch it at the ends

From the topgallant masthead through the upper gaff and to the lower gaff there is a wire span, and from near the end of the boom there is a sheet wire to a screw eye or staple in the deck From the gaff end to the bumpkin ends there should be vangs. All this part must be fixed quite firmly.

The copper sail may be enameled white or left to turn green with the weather I prefer the latter. This green effect may be obtained at once by soaking a cloth in ammonia and salt and leaving it on the copper for a few hours.

The flag may be painted in natural colors, with thirteen stars and stripes. The house flag is also of thin copper, bound on with wire. The trucks at the mastheads may be buttonmolds or cut from wood and gold-leafed. Gold paint will not stand the weather.

The whole hull should be given three coats of black enamel, with the exception of gun port stripes, which are white between the ports. (Continued on page 99)

How to Fix a Noisy Motor

By George A. Willoughby, E.E.

Supervisor of Electric Work, Arthur H. Trade School, S...

Fig. 1. Drilling the rotor of an electric motor to bring it into perfect balance

IF A small electric motor makes undue noise when it is running, the cause should be discovered and remedied before serious damage results.

Among the causes of noise are poor mounting, worn bearings, and unbalanced rotor or armature. If one is not sure whether the noise is due to the mounting or to the motor itself, he can find out by taking the motor from its mounting and placing it on a concrete floor, a solid bench, or a heavy block of wood. If the noise disappears when the motor is on a firm foundation, there is no need of trying to overcome trouble except by taking pains to mount the motor properly.

If the motor continues to be noisy, or perhaps jumps around, when running on a solid floor, bench, or block of wood, the bearings may be worn excessively, or the rotor or armature may be unbalanced. The bearings can be checked easily by taking hold of the shaft and "feeling" the amount of play. If they are worn, they should be replaced.

The way to test for an unbalanced rotor or armature is to take the rotor or armature out and roll it on two sharp, level edges. Two steel straightedges or pieces of plate glass may be used, or, in the absence of anything better, the jaws of a machinist's vise. If one side is heavier than ... rotor will revolve to ... the heavy side is ... Mark this side and then test ... rotor comes to rest with ... side down again, it is evident that it is considerably out of balance.

To balance the rotor, remove a little metal by drilling as in Fig. 1. Then test again. Continue drilling until the rotor rolls evenly and takes no definite position when left free to do so.

Figure 2 illustrates an armature core which has been similarly tested and drilled along the teeth to balance it.

If the part is much out of balance, do not remove all the metal from one place, drill out a little from each side, or drill a number of small holes distributed lengthwise, as in the case of the armature illustrated above.

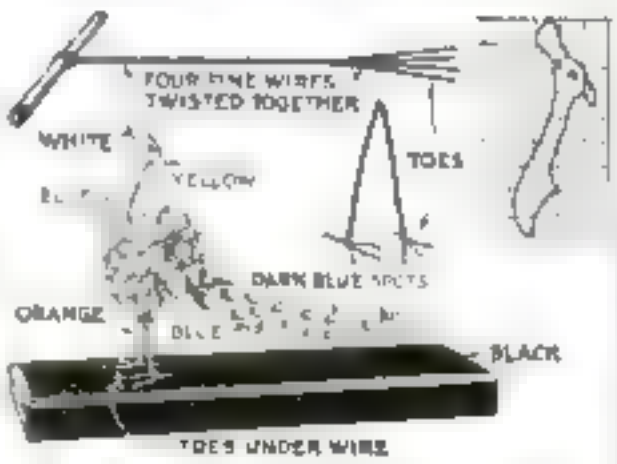
Pine Cone and Feathers Make Tiny Peacock

By F. Clarke Hughes

A PEACOCK "comicuil" is another of the bright little novelties you can make from the humble brown pine cone. Select a cone about 1 in. in diameter, and two straight feathers about 3 in. long. About 12 in. of very fine wire also will be needed.

The two feathers are glued together so that they look like one; then the quill ends are glued into the small end of the cone. The head and neck piece is cut from thin wood. Draw squares on the wood to aid in transferring the pattern. The length of the neck should be 1¼ times the length of the body, so that for a 1-in. cone, the squares would be ⅝ in. Glue the neck in place and put the cone aside to dry.

The feet and legs, which are made by twisting wire together as shown, are fastened to the cone with glue or beeswax.



Mounted on a black base about 1¼ by 1½ in., the peacock forms a brilliant ornament

When the neck and tail feathers have been painted a "peacock blue," a few dark blue spots are added to the tail and relieved with touches of yellow and lighter blue. The cone is left the natural color. The beak is yellow, the plume white, and the legs orange.

Ship-Model Weather Vane

Continued from page 97

The guns may be black or gold. The rigging (all of it copper wire) may be left to turn dark and green with the weather or enameled black.

The rod and arms may be of iron or brass. I used the latter because it is smarter in appearance, does not rust, and is easier to work. The total cost for brass and copper was $1.60.

THE length of the rod will be determined by the position the vane is to occupy. The lower part of mine is 24 in. and the upper part 9 in. I found a piece of tube that fitted snugly into one 3/8 in. so chose those two sizes. From the larger tube I cut 3½ in. to form a sleeve through the rail as previously described.

Four inches from the end of the long, large tube, I drilled a 1/4 in. hole right through and immediately below at exactly a right angle to this a small hole. I drove a wooden plug down the tube and cut it was 1/2 in. or more below the holes.

Next I sat the ends of two pieces of 1/4 in. tube 24 in. long for a distance of 1/2 in. These tubes were passed through the holes in the large tube, with their ends slits vertical. Melted lead was poured down the tube to strengthen the bored part and to fix the arms.

The N S E, W letters were cut from thick sheet copper about 3 in. square. Press them into the slots in the arms and solder them. With black iron arms the letters are best gilded but with brass arms they may be enameled black.

The upper part of the staff—the 3/8 in. tube—was 11 in. long, of which 2 in. were inserted in the 3/8 in. tube and soldered in position. At 4 in. from the end a small hole was drilled and a 1/4 by 1½ in. brass rod soldered in it. On this was placed a brass washer to support the ship. Then another washer, retained as before by another brass pin. The latter keeps the ship from being lifted off the rod in a gale. The ship should balance nicely on the rod.

THE ball, which is the conventional finish below the arms, may be one intended for use on a flagstaff or it can be made of wood. It would be possible to get a copper float from a plumber or junkman and cover it with gold leaf.

At the lower end of the staff there should be a substantial flange drilled for wood screws, lag screws or bolts, as the case may be. This may be screwed onto the end, but it is better if set a few inches from it, so that a hole may be bored into whatever the vane is to be placed upon and the end inserted firmly into it. This takes the heavy strain off the flange. Additional support can be obtained, if necessary, by adding three small brass braces arranged in tripod fashion. Special positions may require special fittings, but the plumber or junkman usually can find something that will serve.

Polish the brass work and give it a coat of lacquer or varnish, and your "Grand Turk" weather vane will be complete. I am quite sure that as you watch it swing to the summer breezes or winter gales, you will never regret the time you spent making it.

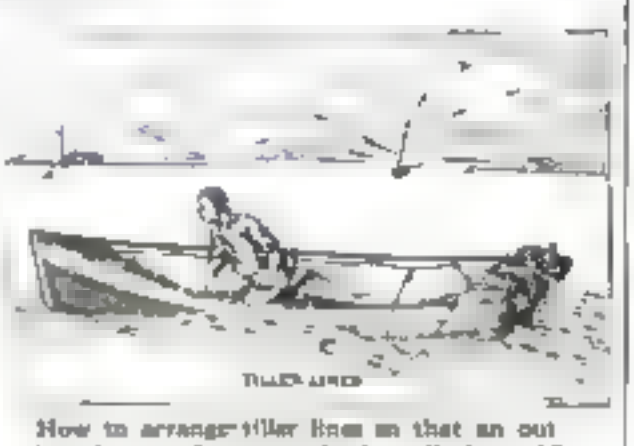
Running *Your* Outboard Motor

Continued from page 4

most cases it is injected into the gear housing by means of a grease gun. Don't neglect this important point. The motor will keep on running for hours after the grease supply has run short, but the wear will be greater than in several years of normal use.

To get good service from any type of gasoline motor, you must have good ignition. Outboard motors are no exception to this rule. And because they are located so near the water where spray is likely to strike any portion of the motor, special precautions have to be taken. It is general practice to provide rubber covers for the spark plugs, and these should be kept in place at all times when the motor is in use. They will, however, sweat and become wet inside, so they should be wiped out each morning if the weather is damp.

Two systems of ignition are in common use on outboard motors: battery ignition and magneto ignition. Either system gives perfect satisfaction. If you get a motor with battery ignition, don't try to operate it on a battery that has become so weak that the motor misses occasionally. Get a new battery and play safe. Also be careful that the battery is stored in a cool, dry place when not in use. If kept near a stove or furnace, it will deteriorate rapidly and soon be unfit to use.



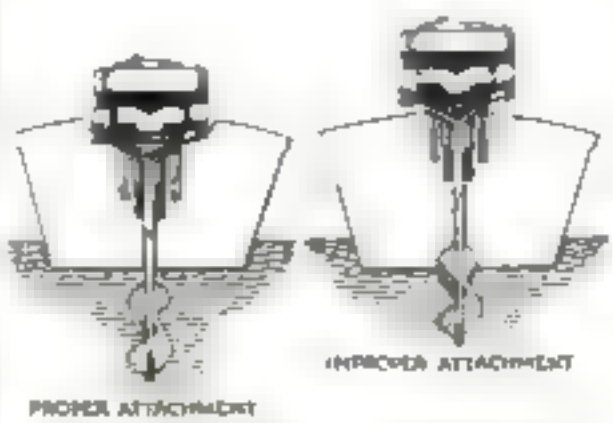
How to arrange tiller lines so that an outboard motor boat may be kept "trimmed"

Setting the needle valve on the carburetor, which must be adjusted with the utmost care

No matter what system of ignition you have, there always is a possible chance for trouble with fouled spark plugs. Putting more than the specified amount of oil in the gasoline is sure to cause trouble. The use of inferior oil or oil of the wrong grade also will foul the spark plugs and cause excessive carbon deposits as well.

Because both cylinders of an outboard motor fire at the same time, a fouled plug does not show up in an audible irregularity in the operation of the motor. The simplest way to determine which plug has quit working is to place your hand on first one cylinder and then the other. If one of them is not firing it will be much cooler than the other. So, if the motor slows down suddenly, let it run for a minute that way until the flow of cooling water has a chance to cool off the cylinder that is not firing.

The high temperature of the exploding gasoline mixture in the cylinders would heat the cylinders up to the sticking point in short order if it were not for the constant circulation of water in the cylinder jackets. Some types of motors use mechanically driven pumps to circulate the water. Others are built so that a portion of the water forced backward by the propeller is directed through passages in the rudder up through pipes into the jackets of the cylinders. In either case no trouble will be experienced provided nothing is allowed to cover up or obstruct the water intake.



The propeller must be mounted so that it is below the keel and runs in undisturbed water

Check up on the flow of cooling water by noting whether it is flowing out of the pipes provided for that purpose. At night, if you cannot see the water coming out, place your hand on the cylinders occasionally to make sure that they are staying cool. Pay particular attention to the cooling system if you are running through water that is full of weeds or in shallows where there is a chance that mud or sand may get in the intake pipe.

Whenever you take your outboard motor off the boat, be sure to drain out the water in the circulating system. The correct way to do this depends on the particular type of motor you have, but in any case if you have been running the motor in salt water and you intend to put it away for more than a few hours, flush out the salt water with fresh water to avoid the corrosion that is bound to occur if the salt water is left in the circulating system and the water jackets of the cylinders. The best way to do this is to stick the propeller into a large barrel filled with fresh water and run the motor for a minute or two so that the fresh water will rinse out the pump and the piping.

If the motor has been out of commission for several (Continued on page 101)

Your Outboard Motor

(Continued from page 100)

weeks, moisture may have worked back through the exhaust ports into the cylinders and caused rusting and sticking. To test for this trouble, remove the spark plugs and turn the flywheel by hand. It should revolve freely. If it appears to be stiff and you hear a slight grating or sparking noise, squirt some cylinder oil into each cylinder and rotate the flywheel until it turns freely.

Of course, this trouble is not likely to occur if you are careful to get all of the water out of the cooling system and the motor is stored where it will be protected from the weather.

In aggravated cases, the water that gets into the cylinders will cause the rings to rust tight in their grooves. Sometimes treatment with cylinder oil and hand cranking will free the stuck rings, but if it does not, a little kerosene squirted in each cylinder and allowed to remain for several hours may free them.

Your outboard motor is bound to run if the spark is good, the lubrication is adequate, the cooling system is working properly, and the mixture that is being fed to the cylinders contains air and gasoline in the right proportions.

A VERY rich mixture, that is, one that contains plenty of gasoline, is needed to start the motor and consequently all types of outboard motors are provided with some means of choking off the air supply while you are cranking the motor.

The proper time to adjust the carburetor or mixing valve is after the motor has run long enough to warm up. And the proper mixture is the smallest amount of gasoline that will run the motor steadily at full power. If you get the mixture too rich, the motor will begin to hit only on every other revolution of the crank shaft. If you get it too thin, that is, shut the needle valve too far, the motor will slow down and sometimes it will backfire and stop.

Two-cycle motors are more sensitive to changes in the carburetor adjustments than are the four-cycle motors used in automobiles. It will pay you to watch the needle valve setting. Striking exactly the right adjustment means speed, economy in the use of gasoline, and freedom from fouled spark plugs.

Speed also depends to a large extent on the type of boat you use and the number of people you take with you. In any type of boat, mounting the motor properly as previously mentioned, is vitally necessary. Another point to watch is the distribution of weight in the boat. Never allow the stern to squat down in the water with the bow sticking up in the air.

When you are boating alone, be sure that you sit far enough toward the bow so that the boat rides on an even keel. The installation of tiller ropes so that the boat can be steered from any position is necessary to attain this result.

The perfection of the outboard motor certainly has revolutionized motor boating. It has put it within reach of everybody. No other piece of modern gasoline machinery, perhaps, can give so many hours of pleasure for each dollar expended.

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

New Machines Aid Mechanics

One Automatically Taps or Drills—Another Welds Long Tank Seams

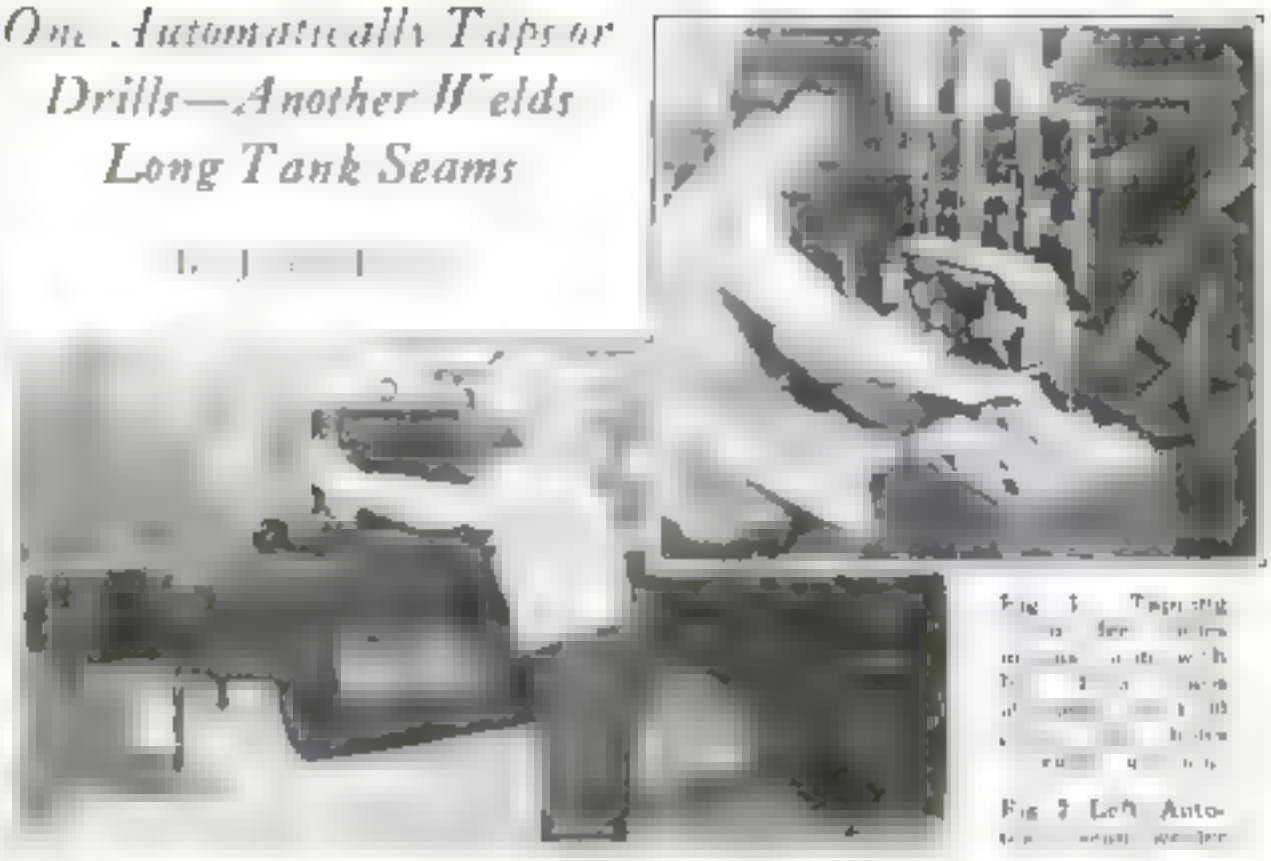


Fig. 1. Tapping [illegible]

Fig. 2. Left: Auto- [illegible]

DICK GOODWIN shut off the motor of his machine just after the noon whistle blew. It was his first half day on a new job, and he had been given the privilege of running a brand-new radial. He paused a moment to survey the machine approvingly, and while he was doing so, his old-time buddy, Henry Grady, who was an older employee, came along.

"Let's go out and get something to eat," Henry said.

"This is certainly a fine machine!" Dick ejaculated. "Runs as pretty as a sewing machine. I don't think I ever saw anything that was easier to handle."

"Well that's not unusual at this plant," Henry snorted.

"Maybe not," Dick replied. "But there is a thrill to taking hold of a machine that runs as nicely as this one. It has so many modern conveniences. All I do to start it is to push the button. The gear box has ball bearings, too. All the gears are inclosed, and some of them are made of alloy steel, and hardened. Then, there is an oil reservoir at the top of the head that keeps all that part oiled. The controls are convenient as well."

"Aw, don't rave so much about this one machine," Henry expostulated impatiently. "Wait until we have eaten, and I will show you about the plant and let you see some real machines!"

That was a sufficient rebuke for Dick, so the two went to the lunch room across the street for a bite to eat.

"Talking about new machines," Henry began just before the beef stew was put before them, "there is a machine (see Fig. 1) in the plant that automatically drills and taps holes in small castings. It is an odd-looking thing. From a distance you would think that part of a caterpillar tractor had been borrowed, but that is only the chain that carries the work. There are several spindles, each of which can carry a tap or a drill. The man running the machine puts the castings on the chain, then the chain moves and the machine goes into action. If it is tapping only, as in the machine in our plant, they use four taps to tap four holes in one casting. Each of the taps works on a hole in a corner of the casting. Then, when the taps have finished the holes, the friction drive backs them out again, and the chain moves up a notch. It is a wonder."

Dick looked over his coffee cup and nodded, although he had not seen anything like that. In fact, he was not very familiar with the more modern machines, and was anxious to learn more of them.

"What else is there new in this plant?" he inquired.

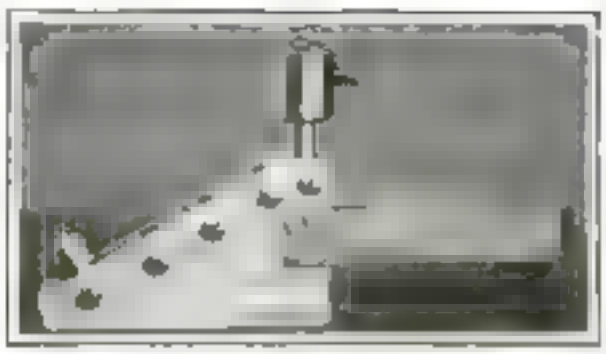
"It would take quite a long time to tell about all that there is," Henry laughed, "so suppose we go for a walk through the plant?"

It happened that just inside the door they used in entering was an automatic electric welder (Fig. 2). This was a machine to weld the

Continued on page 104

Fig. 3. Semiautomatic control on plain milling machine for production work

Diamond Holder for Surface Grinder



The use of this adjustable holder makes it unnecessary to raise and lower the wheel

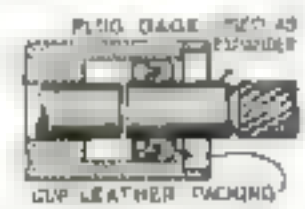
THE diamond holder shown in the accompanying illustrations is provided with five holes for the diamond, so that there are several positions for it at different lengths. A surface grinding wheel can be dressed when it is almost touching the magnetic chuck or when it

How the holder is used when dressing a surface grinding wheel set close to the chuck

is raised as much as 4½ in. In the latter case the removable extension shown in the view above is utilized. This saves adjusting the head up and down when dressing the wheel.—H. J. C.

Installing Leather Packing

WHEN confronted with the task of installing some leather packing in a hydraulic pump, a machinist of considerable ingenuity used a plug gage from the tool room to expand the packing so that it would slip easily over the rod, as illustrated.

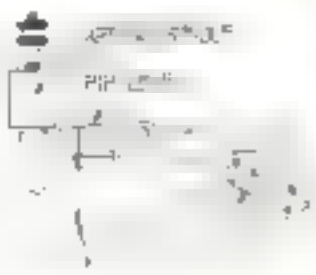


A plug gage expands the leather packing

Similarly, if the packing had to be entered in a hole, a ring gage could be put over the outside of the packing.—G. A. Lucas.

Piece of String Solves a Tapping Problem

IN OPERATING an automatic tapping machine for tapping ¼-in. blind holes in steel, difficulty arose because of the breaking of too many taps. A little piece of string was what saved the day. This was connected to the trip lever of the machine and along with a loop for the operator's foot. At the slightest indication that the tap was about to stick, he could reverse the machine by pressing on foot. Later the foreman and a permanent foot pedal and connecting rod attached to the lever.—JOHN HAGAN.



How string was used to reverse the spindle

New Machines Aid Mechanics

(Continued from page 102)

seams on tank shells. It had a long horn to support the rolled shell and there was an arc welding unit that automatically fed the welding wire into the weld as it was moved by power along the seam. The operator had only to watch the work after the shell was clamped in place. There was no tiresome feeding of the wire, so the weld was much more uniform than if it were done by hand.

Not far from this machine was a small bench tool (Fig. 4) to take the insulation off the ends of wire.

"The boys out here like this little device," Henry said. "It saves them much hard work for you know how difficult it is to get the insulation off the larger wires. You put the wire into the notches there, put your foot on the pedal

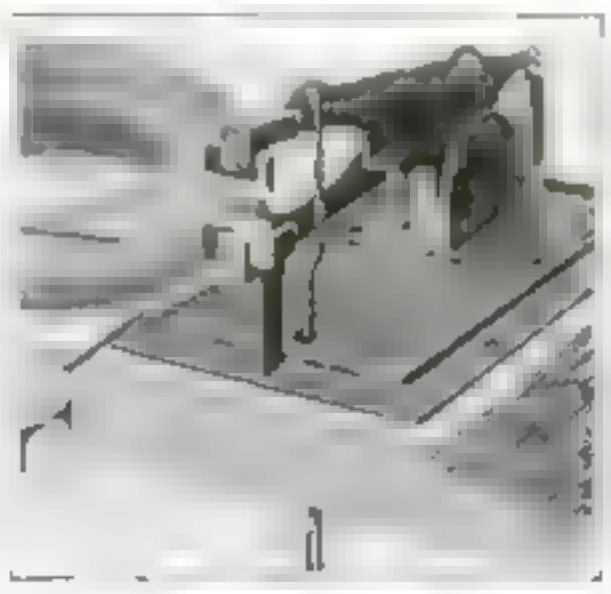


Fig. 4. Bench type of pedal operated stripping machine for removing insulation

which cuts the insulation, then pull the wire out of the blades. It will handle any size wire up to No. 0."

"Looks like it would help a lot," Dick commented.

Returning to the machine shop, Henry paused in front of what appeared to be a small milling machine. It was.

"Here is a machine that is about half automatic," he said. "There is a girl who runs this machine (see Fig. 3). You will notice that there is a foot pedal arrangement. That starts the feed, and the table moves rapidly to a point just before the work reaches the cutters, where a dog changes the feed to a suitable rate for cutting, then, at the end of the cut, the table is automatically reversed and run back to the starting point, ready for another piece. There is a pump in the base for cutting compound."

"It ought to be fast in operation," Dick said. "Looks as if the work is clamped rather far from the cutter."

"That is one of the features of the machine," Henry continued. "There is little chance of getting caught in the machine, and there is no danger of damaging the cutters, for the trip changes the fast traverse to a proper feed at just the right time. This is really a standard milling machine with an attachment to give these automatic changes of feed."

"Looking about the plant, I can see why you have liked it so much, and have kept urging me to come here too," Dick commented. "Here you have all things modern and convenient. You do not have to worry about whether the belt is tight with all these motor drives."

"True, most of the machines are motor driven," Henry replied. "I suppose that this plant is like most of the other big ones: wants to have the best. A little thought about the features on the machines we have looked at will show the trend in modern tool design. Motor drives, hardened gears, pumps to circulate oil, are a few of the changes."

"The one that impressed me most is the manner in which the control levers are arranged," Dick pointed out. "Now on that drill press of mine there is one lever that locks the arm in place. I remember an old drill I used to run that had three nuts on the back of the machine to do the same work."

"And look at the electric welder for tanks," his friend added. "A few years ago we would have driven two rows of rivets to make that shell, a year ago we might have had a welder to weld the seam, but now there is a machine that does the work automatically."

"You know, I used to listen to some of the old boys who seemed to think that things were going to the dogs because their hallowed traditions were being cast aside," Dick said, "but I believe these same old boys would enjoy working with these machines if they had the chance."

"You bet they would!" replied Henry, as they parted to take up their afternoon's work.

Nonremovable "Rivets" for Small Plates

WHAT might be called a "blind" rivet is illustrated. It is intended to take the place of screws under special circumstances when a nonremovable fastening is desired, as for holding small cover plates or name plates. This rivet has been used extensively in one shop because of its simplicity and certainty. It will not loosen from vibration.

A steel ball expands rivet in blind hole

The rivet is a small rod with a hole drilled in one end slightly smaller than a hardened steel ball. With the ball in place, the rivet is driven into a plain hole. When the ball strikes the bottom, it swells the hollow end of the rivet in the manner shown exaggerated in the illustration. The walls of the hole, usually cast iron, expand to a certain extent and allow a slight head to be formed, which is sufficient to prevent the rivet from loosening.

Old Bill says—

WHEN working cast iron on the lathe, take out the chuck jaws and screws and wipe off all oil; this will save you lots of trouble.

Do you know that a finishing reamer, when used with a little oil or compound, will cut a trifle smaller in diameter than when it is used dry?

A little white lead mixed with lard oil makes a good compound for chasing threads, put it on the work with a brush, just ahead of the cut.

Oil should be figured in terms of quality, not quantity

It's much better to oil your machine every morning, than to bathe it in oil once a week.

A good planer hand will wipe off the ways every morning (as dust will accumulate overnight), then apply a little fresh oil. Change the oil frequently in the cavity and roller oilers of the bed. For this purpose a good syphon can be made from an old rubber bulb and a glass tube.

A bar of ordinary washing soap dissolved in hot water, with enough water added to cool it, will make a cutting compound in a pinch, when nothing better is at hand.

Never use water to cool a bearing that has become very hot. As oil will run off and do little good, use a bar of common soap. This expedient sometimes will prevent a tieup in such an emergency as when a heat is being run from the cupola in the foundry and any shutting down would mean a loss.

Pliers Adapted for Knurling

AN OLD pair of pliers was converted into the handy knurling tool for small work illustrated. The pliers were annealed, slotted and drilled for the knurls and holes were drilled for the clamping bolt. No lathe is needed to use this tool. The job may be done on a drill press, or even by hand with the work in a vise.—C. K.

A handy knurling tool for small work, made from pliers

FOR MAKING a narrow slot of a special width, it is more economical to use a screw-slotting cutter, concaved .005 in. on each side, than to grind down a standard slitting saw, provided the depth of the cut is within the range of the cutter. The concaving is done by mounting the screw slotter on a gang arbor and using the cylindrical grinder.—H. C.

Cutting Threads Accurately

Continued from page 187

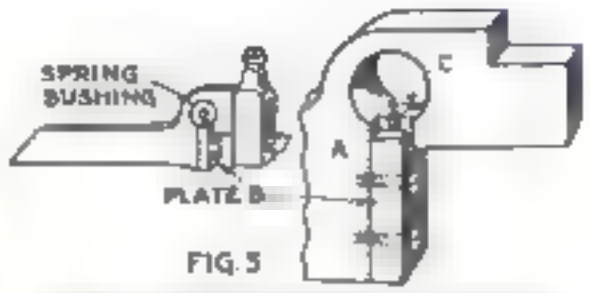


FIG. 5

A shop-made spring threading tool for finishing cuts, which aids in accurate work

doweled together. This construction permits the parts to be hardened and ground. In use, the gage is put on a piece of plate glass and if there is no light visible between the tool and the gage, the tool is correct.

To check the tool gage, a male gage is required, as shown in Fig. 3. This is of thin sheet steel, roughed out, hardened, and ground for accuracy. One method of grinding it is to hold it on a small arbor in an indexing head placed on the surface grinder. The head is set for three divisions, which results in making the angles 60 deg. each. The gage could also be ground with the aid of a sine bar

The width of the flat on a U. S. S. threading tool should be measured carefully for accurate work. This is hard to do unless there is available an expensive vernier thread gage tool. In Fig. 3 is shown a method by which this flat can be measured with a micrometer.

The tool is first ground sharp and length B is measured. Distance D, corresponding to width F, is computed from the formula given. This is subtracted from length B, giving length C, to which the tool should be ground. The grinding is best done on a surface grinder, as hand grinding is apt to be inaccurate.

A fixture for grinding the tool to shape is shown in Fig. 2. This is made of machine steel, pack hardened. With it anyone can grind a threading tool accurately on a surface grinder. It insures that all tools will be of the proper contour

It is essential that a threading tool be set at the exact height of the lathe centers, level on top, and at the same time square with the axis of the lathe. To do this accurately a gage such as is shown in Fig. 4 is useful. This is held between centers. It has grooves turned in it for setting tools for the three commonly used threads, and also a flat at B for setting the tool at the correct height and with the surface level. The flat is adjusted with an indicator so that it is parallel with the ways of the cross slide Then the tool is set with its top in the same plane as the flat.

The finishing cuts on accurate threads are best taken with some type of spring threading tool That shown in Fig. 5 has several advantages, and is to be recommended if a tool is to be specially made. The "springiness" of the tool may be varied by changing the bushings in the hole. The tool is held from being deflected sideways by plate B which holds the parts in line and yet allows the tool to "give" vertically

Fig. 8. The Three-wire method of measuring

The foregoing comments have been chiefly on how to finish the thread accurately. If a carefully ground and set tool were broken during the roughing operation, much time and effort would have been wasted; therefore it is better policy to use a separate tool for roughing out the work.

In Fig. 6 is shown a good set-up for roughing out a thread. The tool cuts on the end only, the chips coming off in long curls. The side of the tool does not cut at all The tool is ground at an angle of about 37 deg. so that it will cut almost to the full depth, leaving little stock for the point of the finishing tool to remove. The compound rest is swung around to slightly less than 30 deg. and the tool is fed forward with the compound rest screw.

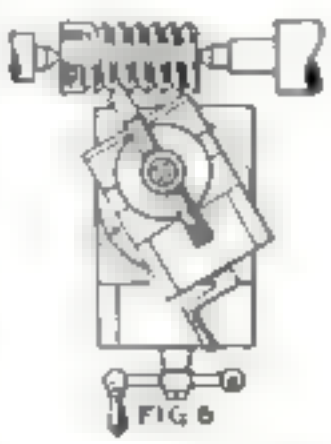


FIG. 6

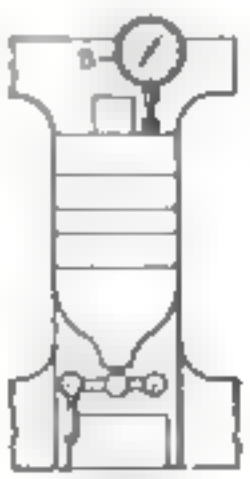
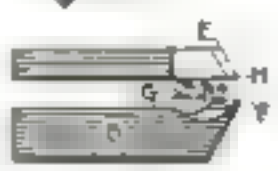


FIG. 7



Set up for roughing cut (Fig. 6) and an indicator used in making finishing cuts (Fig. 7

When finishing the thread, the most important part is, of course, the last few thousandths. Here should be displayed the patience that makes for success. The last few cuts should not be of more than about a thousandth on a side.

For determining the position of the tool when making these cuts, the arrangement of a dial indicator as shown in Fig. 7 has been found much more satisfactory than using the micrometer dial on the cross-feed screw, as it shows where the cross slide actually is, and not merely where it ought to be.

If thread micrometers are available, they will be used to find the pitch diameter of the thread. In their absence, the well-known three-wire method can be used for measuring the pitch diameter This is shown in Fig. 8, where the formula is also given. The wires may be of any size that will *(Continued on page 197)*

Cutting Threads

(Continued from page 166)

rest on the sides of the thread and project above the top. It is best to cool the work before measuring it, as it might have expanded a thousandth.

Many of the suggestions given for cutting male threads are also applicable to internal threads. One of the most important things about internal threads is to have a rigid tool holder and a lathe that does not chatter.

MEASUREMENTS of internal threads are usually obtained by screwing a plug of known diameter into them. How close they are to size is shown by how easily the plug can be inserted

One method of measuring the size of threaded holes is to pour a molten mixture of sulphur and graphite into the hole. When cool, it can be screwed out and measured with a micrometer. Sulphur shrinks very little in changing from a molten to a solid form; that is why it can be used for this purpose.

For cutting threads in steel, lard oil is probably the best cutting fluid. For finishing very accurate threads, white lead mixed with the lard oil improves the finish. Cast iron is threaded dry, while the bronzes may be threaded dry, or some of them with lard oil as a lubricant. Kerosene is usually found to be best for aluminum where it is desirable to use a lubricant.

Two Methods of Holding Short Pins Vertically

How two pins may be held at once by means of a collar and a toolmaker's vise clamp

FOR holding short pins upright while drilling holes in the ends I have used with success the two methods illustrated. In the first, when the clamp screw is tightened, the collar jams two pins together and holds them in a true vertical position. In the second method shown, the pin is held in a tap wrench, which is fixed in a clamp. ARTHUR KENDALL.

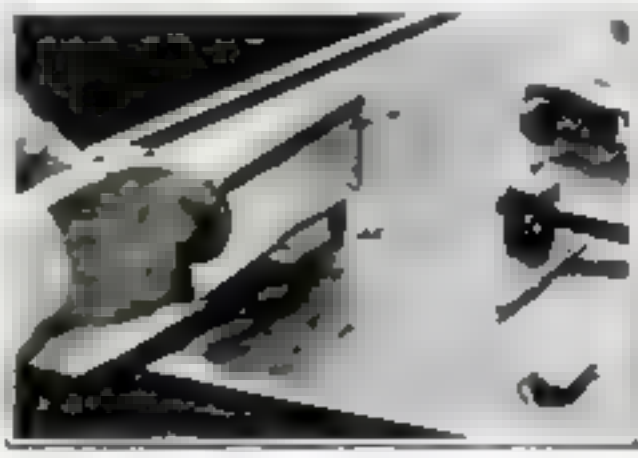
Holding a pin upright by means of a tap wrench gripped between the jaws of a clamp

Fastening a Table Top

How to Apply Wooden Cleats Which Allow the Surface to Expand and Contract

1 Before the frame is glued together, chisel mortises ½ by ½ by 3 in. at intervals of from 12 to 18 in. in each rail. The inside edge of each mortise should be ⅛ in. from the upper edge of the rail. If you prefer, cut a continuous groove with a plow plane or on a dado saw

2 Cut cleats ⅜ by 2½ by 3 or 4 in. Set marking gage to ⅞ in. and gage along one end with gage against side which will be placed against table top. On the same side draw a line ½ in. from end. You can lay out several in one piece and sever later



3 Saw out the waste wood, or saw across the grain and chisel away the waste with the grain, if you prefer that method

4 Bore and countersink two holes in each block, placing them diagonally Use a bit of the same size as shank of screws

5 Lay top upside down on flat surface, adjust frame by measuring all around, and mark each corner so that frame may be replaced quickly if it is accidentally moved

6 Place blocks close to corners and at intervals of 12 to 18 in. Leave at least ½ in. between end of each block and the rail to allow for expansion of top. If wood is hard, bore small holes in top for screws

Whirling Wheels

(Continued from page 24)

That was in September, just before the County Fair opened at Belmont, and it supplied an absorbing topic with which to while away a twenty-mile train ride. If she hadn't dashed out and handed over a prize, would Jim have been a good loser? Certainly he had worn some kind of a grin on his face when he had started toward Gil at the end of the race, but when she had run past him to give Gil the flowers, the grin had disappeared like a rabbit ahead of a dog. He had kept on going, but, with a black frown on his sweat-covered face, had looked down at Gil, still panting, and had said: "You do know something—about bikes, anyhow."

Then he had turned on his heel and left. It had looked for a minute as though he were going to forget the difference in their size. A little matter of rivalry was turning into a serious business.

GIL didn't go to the Fair, even though Zach invited him to go and offered to pay all expenses. Zach took the trouble to do it in the post office, too, where everyone could read the message of the invitation. It pleased Gil.

"Why, thanks, Mr. Weeden," he said, a grateful look in his eyes. "But—there's going to be a motor wagon race in Chicago in November, and I figured that if I stayed home while everyone went away I could work all day in the barn instead of the shop. They're offering a two-thousand-dollar prize for that race—"

So he stayed home and worked like sin, while Jim triumphantly escorted Abby and her mother to a three-day session at the Fair. And Gil missed the race. It was to be held on the second of November, and up to that day nothing but noise had come out of the barn.

Then the news came, by way of Gil, that the race had not been run, after all. There hadn't been enough entries. It had been postponed until Thanksgiving Day. Gil went to work again, harder than ever, and the week before Thanksgiving asked Zach if he wanted to take a ride. Zach did, and the whole town was there to watch, everybody grinning excitedly. Everybody but Jim.

THE barn doors opened and let out such a racket as was never heard in Weedenville, followed by Gil's queerest looking sight they had ever seen—a buggy, dashboard and everything but the top, with big Zach and little Gil on it. Gil was frowning abstractedly and hanging onto a kind of a handlebar that stuck up out of the floor. Steering it. A cloud of black smoke belched out behind. It smelled like a smoking lamp wick and came from some kind of an engine that was hung onto the frame of the buggy under the seat. A couple of belts came out and went around pulleys on the two back wheels. It seemed to steer all right. Gil headed it down toward Main Street. Kept going, too, until, just after he had turned the corner, it stopped.

Gil grinned foolishly and climbed down, grabbed hold of a crank that was sticking out from one side under the seat and turned it. S-s-s, hoosh! S-s-s, hoosh! and that was all. It didn't start again.

"Hey! Get a horse!" yelled a rihald voice that sounded much like Jim's, and that started the crowd to snickering, then laughing. After a while Gil gave it up. Zach climbed down from his seat and called "Give us a hand," and they maneuvered it back into the barn. It wasn't much heavier than a Studebaker wagon. Gil closed the doors and that was the end of the day's performance.

"Why don't you save your money an' buy a horse?" Jim wanted to know in a jeering voice at the post office that evening. "That's the easiest way o' takin' folks buggy ridin'" with a wink at the crowd.

Gil looked up from (Continued on page 110)

Whirling Wheels

(*Continued from page 109*)

a letter he was reading. "I'm not interested in horses," said he.

"Might pay you. Stick some shafts on the back end an' let him push if you don't want to look at a horse," and the crowd cackled. "Maybe he knows bikes, Jim went on, "but it strikes me they's a lot of fools loose at—"

"Yeah, lots of fools," a heavy voice interrupted. It was Zach's, booming from a place near the door. "Lots o' fools. There's fools, there's big fools—an' then you come," and Jim's father, then he walked past his son and looked down at Gil.

"Goin' to get it runnin'?" he asked.

"Not good enough to race," said Gil. "But I'm going to Chicago just the same."

Yes, there were lots of fools. Gil met a good many of them in Chicago—and Jim was there watching them. He brought back a copy of the Chicago *Times-Herald*, the paper that sponsored the first race of its kind in America, and Wendenville wore it out reading it.

THERE were six entries, two driven by electricity and four with hydrocarbon engines. Two of these were Benzes, entered by different men, one a Duryea and one a Roger Wagon, entered by Macy's department store in New York. They raced from Jackson Park out to Evanston and back, but only two of them really raced. There were several inches of snow on the ground with a crust of ice on top, the electrics were stalled by it, and two others failed to get traction in the snow. The Roger Wagon made it a race, but dropped out before the finish, one Benz completed the course several hours late, and the winner was Charles E. Duryea—"An' Gil was hobnobbin' with him an' his brother Frank like he was one o' the family," said Jim. The fifty-four-mile course was covered in an elapsed time of ten hours and twenty-eight minutes, a running time of seven and one half hours. Average speed was better than seven miles an hour! There "might be something in them things," after all.

"There is," said Gil in his quiet way, and even Jim listened—with a twinkle in his eye. "I was on the wrong track, that was all. I've got a Brayton type engine and I hung it on the frame, what I'm going to do is get an Otto type and hang it above the springs."

He went on to explain that the Brayton was a two-cycle engine, and had just been patented in its application to wheeled vehicles by a man named Selden. But his friend Duryea claimed that Selden was wrong, and since Duryea had proved the other engine, Gil was changing.

THEN it was that Jim said his say. "Yeah," he jeered, "if you're mechanic enough to put 'em together.

"I don't see you doing anything to brag about," snapped Gil, and his blue-gray eyes flashed for the first time.

"Naw, why should I?" drawled Jim. "But I'll be racin' you an' your imitation threshin' machine one o' these days—if you ever make one that'll run."

It was Gil who pressed on this time, and big Zach Wenden had a little chuckle to himself. There are times when ridicule, properly applied, has its uses.

"Race?" Gil laughed. "What with, a high-geared bike?"

"Huh?" said Jim, assuming an off-hand manner. "No, not a bike, a Benz Motor Wagon. I bought one."

It was several months before that race was run, but not a day of the winter passed that there was not some discussion of it on the region of the post office. Gil had to wait for his new engine to come, and after that rebuild his wagon completely, Jim's wagon did not appear until after the first of the year, but in those months Gil worked with a sober intensity that he had not shown before, even in preparing for the Chicago race.

The racket from the Caswell barn got to be a nuisance. The neighbors complained that it kept them awake far beyond their bedtime, and Mrs. Caswell's patience became exhausted. She would have requested Gil to find another home except for the fact that she had found his money better than none, as Abigail had said. Recent advices had promised some money from her husband's estate, but in the meantime—she compromised by making Gil pay rent for the use of the barn and stipulated that all noise must cease at eight o'clock. Backed up by the neighbors as she was, there was nothing for Gil to do but agree, though he continued to work, quietly, until late.

"Won't you take me for a ride the next time you make a test?"

This from Abigail across the supper table one evening when the frost was leaving the ground. Time was when Mrs. Caswell would have changed the subject then and there, but she had learned that Gil's consuming interest lay in affairs of mechanics, not of the heart, as she was wont to call it. Gil was safe. He treated Abigail with the same courtesy that he had for everyone else.

"I don't think I'd better," he was replying. "You see, when I go out I'm not sure when I'll get back. When I am, you'll be the first one I'll have a ride."

"But why not now?" insisted Abigail. "I've been out with Jim when he's broken down, and—"

"Abigail, Mr. Herrick is ready for his pie."

SHE got no ride until after the race, which was run on a Saturday late in May. Zach, who had been watching the affair with an altering opinion as to the quality of a jaw, was again selected as the referee. The course was to extend north on the turnpike to Elmont, around the county court house, thence back the same way to the corners at the center of Wendenville, a distance of some forty-five miles. Each driver was to take along a judge, and the race was to be run to its end without help from any outsider. The start was to be made at nine o'clock, one wagon to leave ahead of the other and the winner to be the one who made the trip in the shortest elapsed time. That was because the condition of the roads made parallel racing impossible.

The two wagons were oddly characteristic of their owners, though both were steered by the same handlebar arrangement and driven by Otto engines. Gil's was light like a buggy, with its mechanism visible beneath. Jim's was heavier, more solid-looking, with its engine concealed by the body. It had lower, heavier wheels, and could carry four people, two facing backward as in the smart traps that were being used with horses in the city. Such dissimilarity in appearance, backed by the fact that Jim's was a manufactured product while Gil's was home made, created a sharp division of opinion that was being backed by money. The race promised to be a great event, whether Wendenville could see it all or not.

THEY drew lots for the start and Jim won, leaving at nine o'clock sharp. He took Lem Carson with him. Gil followed at nine-fifteen with Zach as his companion. The fact that such an arrangement caused no comment was a tribute to Zach.

Gil and Zach had covered about three miles at a rapid clip—almost fifteen miles an hour, Gil said—when they had their first news of Jim. The something they first saw at one side of the road ahead proved to be a wagon and team with an exceedingly irate farmer holding up a warning hand. (*Continued on page 111*)

Whirling Wheels

(Continued from page 110)

Gil stopped his wagon at a safe distance and asked Zach to go forward and help calm the horses, and Zach met a tirade.

Jim, it seemed, had come tearing down the road; the horses had begun to act up, and before the farmer knew what was happening Jim had whizzed past, yelling something, and he and his team were piled into the fence "—and if that Jim o' yours don't quit bein around the country with that contraption o his, I'll take a shotgun to him, Zach Wenden!"

Zach managed to pacify him, and held the team until Gil had inched by and they were speeding again, with Zach's head blowing back over his shoulders. Not for long, though, because the road got worse and worse. Rattle, bump, bounce; mud flying until they were covered, wheels spinning, slewing from side to side. Wherever they struck a smooth place that permitted high speed, there, it always seemed, was a team for which they had to slow down. For Gil insisted upon it.

"WOULDN'T have to," he said, "if they watched their horses. But they get so interested in this they forget. Then everybody gets scared."

It was easy to tell which of the farmers had met Jim and which had turned into the road after he had passed. Some were calm and some were not. It was apparent that Jim was not so far ahead. Gil and Zach might have overhauled him if it hadn't been for breakdowns. Twice during the trip they were delayed. Once the trouble was with the belts that drove the rear wheels. They got caked with mud and refused to work, one of them slipping off. It took Gil nearly an hour to fix them. The other time the steering gear broke and they almost went into the ditch. would have if Gil hadn't pushed down quickly on a rod that extended up out of the floor close in front of the seat and brought the wagon to a stop. Gil patched the break with a wire and a nail from his tool kit—another thirty minutes lost—and they went on. No sign of Jim after that.

What with breakdowns and the slowing down for bad roads and uncomprehending horses, it was afternoon before they reached the outskirts of Elmont. There progress was very slow; a walk, in fact, for Gil asked Zach to walk ahead, like a circus man before his elephants, and calm the horses they met. It was Saturday, and there were plenty of horses to watch, too. The cautious proceeding proved to be a fortunate one, though, for when they were looping around the square on which the court house stood they saw Lem Carson. He was sitting alone in the wagon surrounded by a crowd, and when they asked where Jim was, he said: "Locked up."

IT DEVELOPED that Jim had pursued his customary tactics in going through Elmont. One runaway had resulted, fortunately without harm except to a brand-new buggy, and the local constable had ordered Jim to stop.

"I'm runnin a race," Jim had cried. "I can't stop. I'll come back an' fix it up."

"Stop, I tell ye!" bawled the constable, who was loping along beside them. Lem had seen signs of rage and wanted Jim to obey, but that was not for Jim.

"Don't you know who I am?" he called back. "I'm Jim Wenden, Zach's son; I'll—"

"Don't care if ye re Grover Cleveland, President o' the United States! I order ye to stop in the name o' the law!" panted the officer.

Then Jim stopped, but left his engine running, and the rows of horses at the hitching racks around the square continued to snort and prance.

"Stop that noise!" ordered the constable, and Jim changed his tone.

"Now look here, (Continued on page 112)

Whirling Wheels

(Continued from page 111)

constable. I ain't hurtin' nobody. I'm just runnin a race. If I stop that engine—

"Stop it, I tell ye!

"—maybe I can't get it started again.

"Ye're disturbin the peace o the sovereign city o Elmont," bawled the constable, "an I arrest ye in the name o the law!"

Jim reached down and stopped his engine. "There," he said, very softly for Jim Wenden. "Now let's fix this thing up."

"Too late," snapped the Law. "Ye're under arrest"—and that was as much as he would say.

Gil had to laugh. Zach too. "What'll we do, go on?" asked Zach.

"You can get him out, can't you?" said Gil.

"That'd be outside help."

"Oh, well, this is different."

Another hour was lost getting Jim out of jail. It was three o'clock before Zach's influence and a bond to assure payment for the damage to a buggy got Jim released and they had crawled to the edge of town.

"GIL gets a half hour start," ruled Zach then. "You'd be in jail yet if he hadn't stood up for you." His eyes were twinkling. "Hold him to it, Lem," and they were off.

Homeward bound, things seemed to go better, for Gil had learned a few tricks. He observed, for instance, that it was always one belt that jumped off its sprocket, and always on a curve. So he removed the offending belt and used the other—and his troubles ceased. Furthermore, he had learned to gage the road and to steer more carefully on this, his first long trip. They must have been going a good fifteen miles an hour and Zach and they were halfway home, when the steady pushing sensation of a smoothly running engine vanished. They were coasting. Gil found a wide place on the road, pulled over to one side, and stopped.

This time it was bad. After investigating—on his back under the wagon—Gil reported that the sparking lever on one cylinder was bent and would not make a contact. It was useless to try to run with the remaining one, and the only thing to do was build a fire beside the road and try to straighten it. That took more than an hour, this time with Zach waxing impatient and casting anxious glances back along the road. Long before they could start again Jim passed them triumphantly, but Zach figured that there was still a chance of beating his time. He must have had some trouble, too, or he would have passed them sooner. "Or been careful to slow down for teams," he added with a chuckle.

ONCE on the road again, everything went nicely, the wagon having decided not to misbehave further. They pulled up at the crossroads in the center of Wendenville just before six and found that the entire population had gathered there. Jim, it seemed, had finished the race by pushing his wagon the last three blocks. It would have taken longer to fix it than push it, and once there was no rule to the contrary. Lem had allowed it.

Then Lem and Zach got together to compare the times, while the crowd waited silently. Those who had made themselves unofficial timekeepers knew that it was close, but Zach's word was necessary before money could change hands.

"The winner," his big voice announced, "is Jim. That counts time in jail an' everything," he added with a laugh.

But no one heard the last, they were yelling. Gil jumped down from his wagon and hurried across to Jim's, ready with a smile and extended hand to offer congratulations. He felt no anger and showed none. He knew that the Benz had come from Europe, where already there were a number of producing factories; he knew that this race had taught him many things about his wagon. He was going to say so, but Jim was otherwise engaged. He was standing erect in his wagon and searching through the crowd.

"Here's the winner," he yelled, grinning, "where's them flowers?"

Silence. There she was, not far from the edge of the crowd. They pushed her out into the cleared space about the wagons. She displayed empty hands and began to speak, but Jim gave her no chance.

"All right," he cried, "I'll take a prize anyway."

He leaped to the ground—the side opposite where Gil was standing—and made to seize her in his arms. He was going to kiss her, that was plain; in fun, though he had never made a move like that before—in her direction. And she was not willing to play. Her blue eyes flashed, she snatched herself free and swung a stinging palm, but what chance had she against those mighty arms? They tightened again and Jim's head bent down—just as Gil arrived.

NO ONE had seen him rush around Jim's wagon, but they saw him arrive. They saw him demonstrate that one may pass off jibes with the patience of Job, but may not live for a year beneath the same roof with a girl like Abby Carwell and not fall victim to her young charm. Suppose the cold eye of a watchful mother had been constantly present, suppose their talk had been in commonplaces, with Gil an increasingly preoccupied planner of something new and strange? There she had been, every day. Now she was being publicly mauled by a strong-arm bully. He flung himself viciously upon big Jim Wenden.

And Jim—he knew all this, too, and laughed! Here was what he had been waiting for: he took a blow from Gil without attempting to protect himself, then reached out a mighty hand and gripped him by the shoulder.

"Look out, little man," he growled. "You might hurt yourself!"

Gil made a violent effort to hit him again, but his reach was too short; his fist swung wildly. What fools we are when rage consumes us! He twisted violently, swung again, and struck. Then Jim shifted his grip, seized Gil's left wrist, and laughed loudly. He had Gil helpless in the painful grip of the hammer lock.

"HAD enough? Better take your go-wagon an' run along home, son."

But he forgot that Gil was mad, and indifferent to the threat of pain. Gil jerked, something snapped—the bystanders heard it—and he planted one last futile blow before he fainted.

It did not the slightest damage, that blow. No physical damage, that is. But the punishment Gil took in order to deliver it, the very foolhardiness of it, swept him on, past the place where fool's deeds take them, into the realm of a man's estate. Jim Wenden, conqueror, was defeated then and there, defeated by a crowd that shouldered him roughly aside, and by the girl who rushed to give aid to an unconscious lover.

The feud is on—two youths in bitter rivalry for speed supremacy and for the favor of a blue-eyed girl. Even in defeat, Gil Herrick has won the first round. But what of the next?

Next month's installment is loaded with dramatic situations, unfolding the romantic story of the beginnings of motordom.

Commander Byrd's Story of Lindbergh's Flight

(Continued from page 11)

on our Polar flight because it is not reliable in high latitudes. Conversely, neither Lindbergh nor Chamberlin could have used my sun compass during the night over the Atlantic. Engineers knew well that the earth inductor compass was a practical and accurate instrument under ordinary conditions. But it took the flights to Paris and Germany to win for it the full confidence of the great body of laymen.

In like fashion did Lindbergh and Chamberlin prove the reliability of their other instruments. Had their altimeters been sluggish or inaccurate at night or in fog they might well have crashed to the surface of the sea before they could have caught themselves. True, we have been using altimeters for a long time now. But it is profoundly reassuring to know that many unbroken hours of high speed flying does not put them out of kilter.

NEXT to the compass I think we should take off our hats to the motors which made both flights possible. It was of the air-cooled type which I have been favoring for a long time. There are no water pumps, feed pipes, drains and strainers to become stopped up on such motors. As the cylinders are designed for automatic radiation they do not suffer the risk of overheating from water failure that the water-cooled motor faces.

Of course every airplane motor is tested "on the block" before it is installed. This gives data on its fuel consumption and shows up any inherent defects in design or assemblage. But conditions in a testing room are far from what they are in the varying air strata encountered in a flight over the ocean. Temperature, pressure and humidity vary widely almost from minute to minute on such a flight. Both carburetor and engine are put to tests that are impossible in the laboratory.

Airplane industry is still in its infancy. So few are our manufacturing plants that one nearly always thinks of the stunt plane as built essentially for the trick it is to play. Lindbergh actually tried to order such a plane, but failed. When he had on the monoplane that finally took him to Paris he had to accept a type that the company he approached could regularly build, and was able only to add somewhat in the way of dimensions to make it fit for the great venture. In other words, planes similar to his could be turned out in quantity with perfect ease. Is not this a true step forward?

ALTHOUGH aviators are primarily interested in the technical aspects of the trans-Atlantic flights, we cannot blind ourselves to the more imponderable things which they accomplished for the good name of aviation. They showed unmistakably that the airplane has become a factor to be reckoned with in international relations.

Before Lindbergh arrived in France the people were aggrieved at our position on the debt settlement and disappointed at our seemingly selfish attitude toward their other troubles. The handsome and heroic, though quiet and returning, young aviator they found within their midst instantly struck a human note of responsive friendliness that months of diplomacy could never have attained. In like manner Chamberlin's magnificent "On to Berlin" flight served immeasurably to bring a new understanding between the people of America and Germany.

The New York-Europe flights suggest that a tense international situation may well lend itself to mitigation by the exchange of envoys by air. I predict that once trans-Atlantic service is established, say twenty years from now, there will be life-size statues of Lindbergh and Chamberlin in the home office.

They will certainly have deserved it, too.

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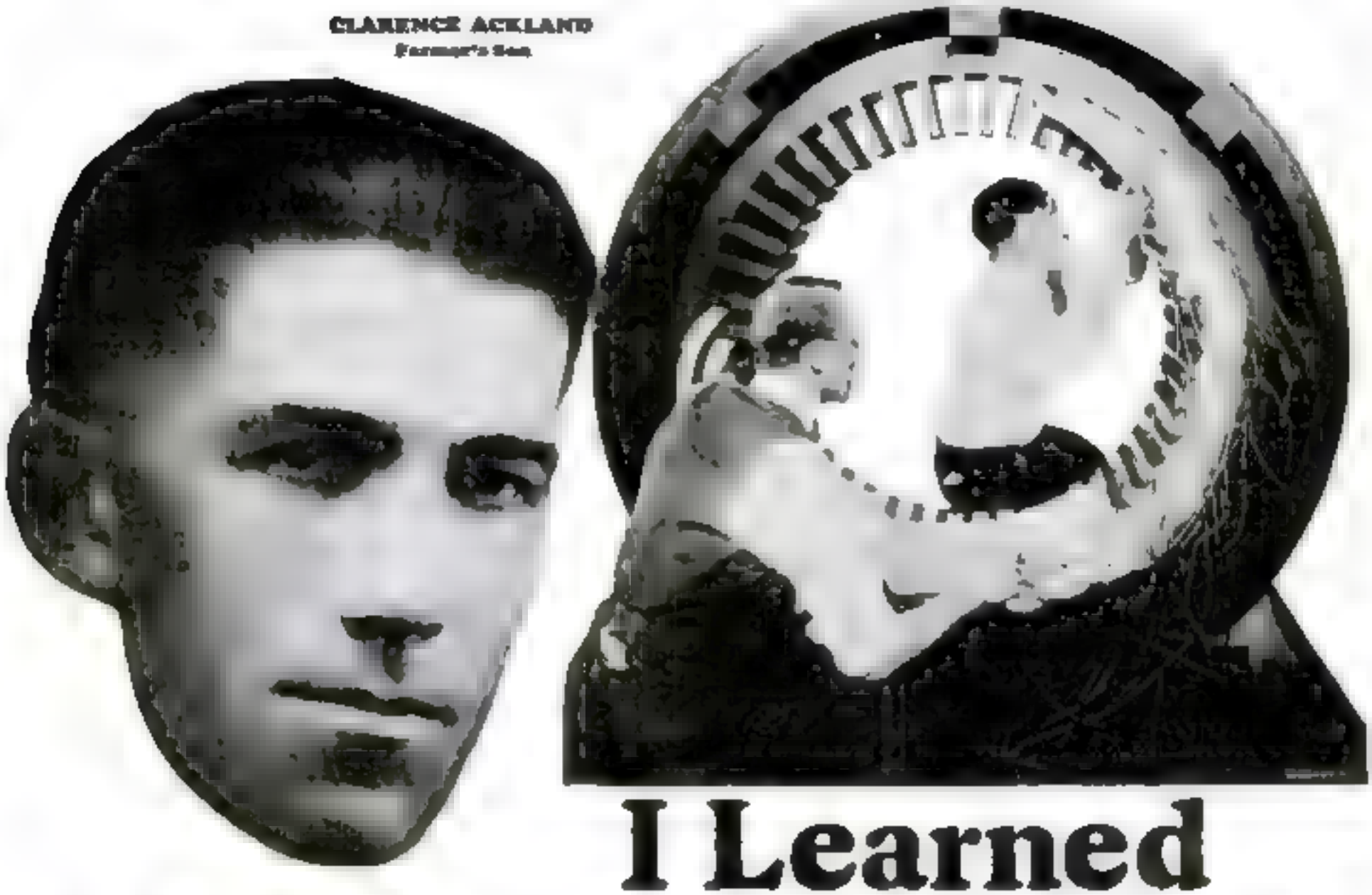

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CASH Paid for dental gold, false teeth, diamonds, jewelry. Mail to Hobart Uhler, Graduate Dentist, Akron, N. Y.

TATTOO INK Learn how with my outfit. Descriptive circulars sent anywhere. Sergt. Bunney, 367 South Main, Providence, R. I.

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SPECIAL Machinery or parts. Dies, Tools, Metal Specialties. Model special gears, worm gears and Model Supplies. Send 2c for Catalogue. The Pierce Model Works, Tinker, Park 111.

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SPECIAL machine builders and die makers, inventor's models, production work of all kinds. Tight & Quaife Hardware & Machine Co., Ravenswood and Thorndale Avenues, Chicago, Ill.

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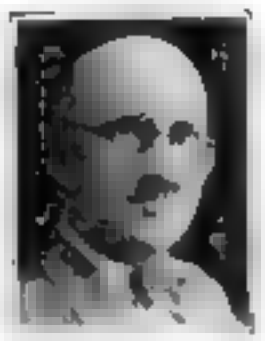
THERE'S *trouble* ahead for men with little education. Big changes have come over conditions around you, and unless you understand THESE them, you haven't a chance in a thousand.



O. C. Miller

Millions of men armed with DIPLOMAS are marching into the battlegrounds of industry. These high school and college graduates are elbowing older fellows with less education out of the way. They are grabbing off the best jobs and promotions. What chance have you in competition with them?

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It's true that up to ten years ago men with only common schooling could make some sort of a living. But remember then they were competing with uneducated men like themselves.

Today, you see the youngsters of your own family, of neighbors, relatives and friends, all going to high school. Three out of five go on to university. *565,000 graduated this year*, and the number is increasing.

Employers know this. And you will find it harder and harder to get a good job or to advance against the rivalry of men with MORE SCHOOLING. You are up against a *real danger*. The cards are stacked against you and unless you do something about it, you are headed for the bread-line of employment—or hard, physical labor.

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It may be impossible for you to go back to school—and you don't need to. We have studied this problem, and have found the solution. We have found there's one thing that employers prefer to a DIPLOMA. That's expert knowledge, *specialized training*.

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HAVE your manuscripts typed. Write for free sample of our big magazine advertising book to make better prints on any camera. American Photography, 147 Camera House, Boston, 17, Massachusetts.

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PEACH Orchard for sale on the Gulf. Monthly payments. Guaranteed crop. Big quick returns. Suburban Orchards Dept. A, Biloxi, Miss.

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AGENTS Wanted to sell wood soles. Get details. Webster Soles, Greenwood, Oregon, Ill.

AGENTS make $100 an hour taking orders for our 60 fastest selling $1 item specialties. No competition. Write quick. Consumers Products Co., Dept. D-233, Newark, N. J.

Wanted salesman to complete line of automobile tools sold direct to mechanics and repair shops. Excellent proposition. Big commissions. Automotive Tool Mfg. Co., Milwaukee, Wis.

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AGENTS $240 monthly. Rotary beside. Sell first time with brushes. Guaranteed. Samples furnished. Write quick. Better than Fuller Brush. Write quick. Better than Fuller Brush. Reconsidered, Ohio.

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ARE you old at forty? See our advertisement on page 107 of this issue. The Electric Thermal Company, 2071 Main Street, Stamboville, Ohio.

A PAY $5 position open a representative of other parties. Take orders shoes, hosiery direct to wearer. Spot cash. Premiums. Write now. Fashion Shoe Mfg. Co., B-50, 6th Ave. So., Minneapolis, Minn.

AGENTS Make $10 Weekly selling "Gray Seal" Automatically. Install in and permanently seals all tire punctures. Saves tubes, prevents blow-outs. Demonstrator sells every car. Write for $2.50 to $5.00 price for you. Exclusive territory given. Write quick for guarantee. Write today for our very liberal offer. Gray Seal Products Corp., 306 Gilpin St., St. Louis, Mo.

AGENTS Big thousand dollar profit on our patented thermal product. Inexpensive sales plan. 100% profit. Commission in advance if wanted. Manager, Box 920, New Castle, Ind.

AGENTS Make $10 Weekly selling "Gray Seal" Automatically. Install in and permanently seals all tire punctures. Saves tubes, prevents blow-outs. Demonstrator sells every car. Write for $2.50 to $5.00 price for you. Exclusive territory given. Write quick for guarantee. Write today for our very liberal offer. Gray Seal Products Corp., 306 Gilpin St., St. Louis, Mo.

Sales Promotion

EXPERIENCED promoter new products personally writes folders, booklets, complete campaigns. Reasonable. Box 56, Orange, N. J.

Shop Equipment

$10 A DAY a business by repairing tires and batteries. The equipment runs light to own and operate. Whole sale only. Get free catalog. Adams-Barr, Columbus, Ohio.

Stamps and Coins

STAMPS, 100 All different, 4 cents. Lists free. P. H. Hunter Stamp Co., Toledo, Ohio.

STAMP Collectors Phillips Stamp Only Bulletin. Illustrated offers over 2000 special bargains, sets, packets, etc. each issue. Free. Phillips, Box 1015, Hartford, Conn.

1933 coins, large Fall selling ex. assortment of coins for sale free. Ex. discount during prime sale for coins, sets, cents. William Hesslin, 1010 Tremont Street, Boston, Mass.

CALIFORNIA gold $1/4 size 17c $1/4 size 33c. White cent and catalogue, 10c. Norman Schultz, Box 746, Nutley, New Jersey.

150 DIFFERENT mixed foreign stamps, 3c. Hinton (144) Niantic, Conn.

50 DIFFERENT Portugal Colonies 10c, 200 different world, 10c. Lists 3 cents. Hamilton, Pa.

50 VARIETIES mixed free. Postage 2c. P. H. Stamp Co., Toledo, O.

500 GOOD mixed foreign stamps, 10c. Approvals. Lincoln Stamp Co., Dept. 1, Omaha, Nebr.

STAMPS, coins, bills, curios, catalogues, etc. Big illustrated 144 page bargain list 4 cents. Numismatic Supply Co., Box 1, Lancaster, Pa.

STAMPS Collections, packets, sets, approvals. Big illustrated bargain list free. Scott Stamp & Coin Co., Dept. 1, Wichita, Kansas.

Miscellaneous

AGENTS Sell our line high class printing at half price. Appeals to every one in business. Liberal commission with order. Samples free. Free cut service. H. Williams Co., Auburn, Indiana.

AGENTS Sell our line high class printing at half price. Appeals to every one in business. Liberal commission with order. Samples free. Free cut service. H. Williams Co., Auburn, Indiana.

No More Punctures!

-Amazing Fluid Makes Tires Immune

Goodbye Tire Troubles! No More Worries About Punctures, Slow Leaks and Valve Leaks! AIR-STOP Seals Them the Minute They Start. Right While You Drive. No Fuss. No Bother. No Changing of Tires! Generous Sample Offer to Motorists. Wonderful Big Money Proposition for Demonstrators and Agents! Investigate Details Today!

Demonstrator Makes $50 a Day!

IMAGINE being able to drive as many as fifty nails into an ordinary car tire without a slight leak. Imagine getting a tire across which a razor-sharp knife was drawn, and the tire still holding air! Now imagine trying to say that AIR-STOP is the most surprising auto discovery of recent times!

Wonderful Money Maker

So astonishing is the effect wherever AIR-STOP is demonstrated that agents and dealers are literally coining money. In a few hours with a few customers, some of their profits are really astounding. L. H. Wagner made $33 on one two weeks. J. H. Kinser made $22.25 in 3½ hours. Hundreds of others are doing as well or better—in full or spare time.

All you have to do is hammer nails into an old tire in front of auto owners, crowds on main streets, etc. They simply can't believe their eyes when you pull the nails out and the tire doesn't leak a bit! But you don't have to have a car to make money with AIR-STOP. Just an old casing mounted on a rim for demonstration is all you need to take in $5 or $15 an hour. And look if big prospects! EVERY auto owner is intensely interested, whether he drives a Chevrolet or a Rolls-Royce—because it's a wonderful way and inconvenience of changing tires.

Self-Acting

AIR-STOP—the amazing new tire fluid—seals punctures automatically while you drive. No matter how many nails you run over it doesn't make a bit of difference. You just keep spinning along as if nothing had happened. And that's not all. AIR-STOP not only seals punctures but slow leaks, valve leaks and pin-hole leaks as well. It even prevents cracked rim walls and rim cuts and ripples tire mileage because it eliminates driving with semi-flat tires, which is ruinous to any casing.

AIR-STOP is a simple harmless fluid you just put into the tire with a common grease gun. No implements to buy. No tire to change. Actually helps PRESERVE rubber. Never hardens in tire or becomes lumpy. Does its work equally well in summer or winter—whether the thermometer registers 20 below zero or 100 in the shade. AIR-STOP never rots and a single application lasts the lifetime of any tube.

Just think what this marvelous discovery means! No more changing tires in hot, dusty roads or blowing out tires in pitch dark nights. No more patching tubes. No more vulcanizing. And think of the economy!

SURPRISING

reports on AIR-STOP are pouring in from users and agents all over the country. "The users tell us how they already the new discovery ends tire troubles—and the agents tell us what a wonderful money-maker it is at the same time!

54 Punctures—No Leaks!

"Read my AIR-STOP sample and gave same a thorough test today. We used a 4.40-21 tire, driving 54 spikes into the same and filling it. AIR-STOP entirely satisfactory!"—Ralph Weiss, Pa.

Profit $112.00

"Have disposed of 56-set order (profit $ 22.00). Will send order for 200 sets by mail." Peebles, Ohio.

FREE SAMPLE OFFER

And now to introduce this amazing invention, the discoverer—Mr. W. K. Hillers to send you a full size sample FREE! And more than that, he actually PAYS you for your cooperation in testing it if you are not surprised and delighted with results. Did you ever hear of such an open handed offer? Of course we can't afford to continue it indefinitely—and are limiting it to 30 days only. So act at once. Take advantage of the opportunity to see for yourself just astonishing AIR-STOP really is! Clip the coupon now! Mail it today!

AIR-STOP MFG. CO.

L-535 Hewitt Bldg., Des Moines, Iowa

AIR-STOP Mfg. Co., L-535 Hewitt Bldg., Des Moines, Iowa.

Please send me full details of your offer of samples of AIR-STOP and your agreement to pay me for testing them if I am not satisfied and enthusiastic over results. Also give me details of generous commission to demonstrators.

Name ..... Address .....

City ..... State .....

Stamps and Coins

500 DIFFERENT [illegible] $3.50 [illegible]

[illegible]

[illegible] STATES and Foreign Coins [illegible]

[illegible]

STAMPS [illegible] for money-saving approvals. John K. [illegible], Cedar Falls, Iowa.

Stories Wanted

STORY Ideas Wanted for photoplays, magazines. Big demand. Accepted any form for revision, development and submission to markets. [illegible] Send manuscripts for free criticism. Booklet mailed on request. Universal Scenario Company, [illegible] Western & Santa Monica Bldg., Hollywood, Calif.

Technical Schools

CHICAGO Technical College offers short, intensely practical courses in Drafting and Engineering [illegible] mechanical, electrical [illegible] Architecture, Building [illegible] Plan Reading, etc. [illegible]

Tobacco

[illegible] Tobacco [illegible] Chewing [illegible]

[illegible]

Typewriters and Supplies

[illegible] Typewriter. Any make. [illegible] Pittsburgh, Pa.

Wanted

DETECTIVES needed everywhere. [illegible] Write American Detective [illegible]

[illegible]

WANTED [illegible] motors [illegible]

Getting Ahead?

Read the advertisements on Pages 114 to 135 this issue if you want to get ahead!

First Plane to Germany

(Continued from page 14)

field" for this purpose. "I believe that my experimental development of a seadrome unaffected by waves, large enough for an ocean landing field, has been adequately demonstrated and a practical and tested anchorage system evolved so that commercial, everyday duplication of Lindbergh's and Chamberlin's feats is a matter only of finance and the relatively short time necessary to build the structures. It may be a reality by 1930."

Chamberlin and Levine flew at all levels from seven to seventeen thousand feet in an effort to dodge storms. At one time Chamberlin even threw overboard some tanks of gasoline, sacrificing the precious fuel to lighten his ship and weather the storm. Before ocean flying can become practical the authorities agree, adequate weather data must be available.

"Weather stations along the ocean," says Grover Loening, noted aircraft designer, "coupled with development of the seaplane to have an equally long range, would result in regular ocean flights within a period of ten years."

"THE flight has not added anything of moment to the science of aviation," was the surprising comment of Giuseppe M. Bellanca, designer of Chamberlin's plane. "I knew the plane. I knew that its motor would propel it for approximately forty-eight hours with its supply of gas. All that had to be done was to get on and pilot it. It took courage to do it, naturally, but simple figures told me the plane would get there.

One reason for Bellanca's confidence, of course, was the fact that the plane, only a few weeks before, had established a new world's endurance record, flying for more than fifty-one hours without stop. Moreover the design of the ship embodied an unusual departure in monoplane construction. Though classed as a monoplane, it is technically known as a "sesqui" plane, or "plane and a half." It is a cross between a monoplane and a biplane, for besides the wings, almost every part of the plane helps to lift some of the weight. Even the wing struts are built with a wing section so that they lift a few hundred pounds of the total load.

Future trans-Atlantic planes, Bellanca predicts, will be multi-motored craft rather than single-engine planes such as Chamberlin and Lindbergh used. In case one motor fails, there will be enough reserve power to fly the machine with full load. There will be spacious cabins, comfortable berths and chairs in these planes, and passengers will buy their tickets, get their passports and board the planes just as they board ships now.

WILL his prophecy come true? Temporary obstacles, chiefly the difficulty of carrying heavy fuel loads, are pointed out by Glenn Curtiss, pioneer airman. "Trans-Atlantic flights will take place with the establishment of filling stations," Curtiss telegraphs, "but will not be commonplace until a revolutionary invention in motive power is accomplished. I do not like to prophesy when such an invention may occur, but it is already in the minds of practical inventors."

E. V. Rickenbacker, famous American flying ace, predicts that within five years "Americans will demand and have available a regular oceanic service of forty hours, with greater safety and comfort than that available today on our finest ocean liners." Second Assistant Postmaster-General W. Irving Glover, in charge of the U. S. Air Mail, is even more optimistic. "My prediction," says Glover, "is that within two years *Leviathans* of the air will span the ocean between America and Europe."

Bare Hands

(Continued from page 4)

wind, and lay drifting as the sun rose above the glassy water. Kuka Joe had disappeared utterly in the trackless sea.

"We'd better catch the schooner again, advised Thornton. "Gee, I'm responsible for that. I wouldn't have done it for the world.

"You're crazy," replied Williams. "You didn't do it. It was his conscience, and you know it. He was as guilty as hell, and he deserved something even worse.

They made their way to the schooner and climbed aboard. The wind had died, and the vessel lay becalmed upon a glassy sea. Not a soul save Tuginana was on deck, and she sat cross-legged by the wheel chanting a wild song.

THAT Kuka Joe was drowned they knew, but they knew also that his crew could tell them what had happened to Parker, and as they went forward to the forecastle hatch, determined on routing some of the fellows out.

"If they killed him," threatened Thornton, "we'll take the whole bunch of them to Kuka Island and turn them over to the authorities. They're scared stiff, and Tuginana could keep them all below for a week."

They peered into the dark and evil-smelling forecastle and shouted for the men to come on deck. There was no answer. The crew were quivering with fright in their bunks, sure that still more devils had joined Tuginana's spirit.

"Rout some of them out, Oomak," ordered Thornton. "Bring 'em on deck!"

Oomak unhesitatingly went below, and appeared, presently, with the mate, whom he held by the coat collar and pushed up the ladder before him.

"Want more man?" asked Oomak.

"Who is this?" questioned Thornton.

"He mate," replied Oomak.

"Then he'll do. Do you speak English?" asked Thornton fiercely.

The man grunted and nodded his head with a jerk.

"What did you do with the white man you took away from Devil Island?" demanded Thornton.

"Not nothing," quavered the mate.

"Where is he?" thundered Thornton.

"He below. He in hold. I get."

THE fellow started aft, Oomak still holding to his collar, the others following.

"Is he lying?" asked Williams.

"I'm hanged if I know," replied Thornton. "But if he is I'll wring his neck."

The mate stopped beside a hatch, and started to take the tarpaulin from it.

"Is he in there?" roared Thornton, furious at the thought.

The mate jerked his head up and down in a frightened nod. Thornton threw him aside, seized the tarpaulin, and tore it loose. He lifted the hatch cover with the aid of the others.

"Parker!" he roared. "Are you down there?"

"Yes," came a weak voice. "Who are you?"

But Thornton did not reply. Instead, he leaped into the foul-smelling hold, and seized his friend. For a moment he could say nothing and tears of joy filled his eyes.

"How did you come here?" asked Parker weakly.

In our boat, thundered Thornton, in an effort to cover up his feelings. "Come on deck, old fellow. Here, I'll boost you up."

A hundred questions were rained on Parker as soon as he reached the deck, and he did his best to answer them.

"Have they kept you in that filthy place all summer?" asked Thornton.

"No," replied Parker. "They took me to the island where they cache their skins, and turned me loose there, after setting every one the task of watching me. I was there until about a week ago, and then a Coast Guard cutter suddenly appeared, and they barely managed to get me away in a canoe. We were in that flimsy thing for two nights and a day, and finally they got me to the schooner. I've been in the hold ever since. Frightful, isn't it? Say, you haven't a cigarette, have you? Oh, of course not. It seems to me almost as if you must have come direct from home."

For half an hour they talked, and at last they called the Aleut mate to learn where they were. Thornton began to question the fellow, while Williams, who had found a pair of binoculars on deck, Kuka Joe's probably—was sweeping the horizon with them. The sea was glassy smooth, and not a breath of air stirred. The schooner's sails sagged listlessly as the vessel lay becalmed.

"WHERE are we?" demanded Thornton of the mate.

"Fifty mile from Kuka Island," replied the frightened fellow.

"Which direction?"

"South."

"South? How can that be?"

The mate was obviously frightened but he insisted that he was right.

"Well," remarked Parker, "your steamer is better than this schooner. Let's get in her and head north. By George, Thornton, how you did it I don't know. I would have sworn it was impossible."

"Hop in," suggested Thornton, "and we'll show you how she works."

Williams was staring through the binoculars toward the west.

"I think," he said, "that there's a better way. A ship is coming."

"Where?" cried Thornton.

Williams pointed.

"I don't know where she's bound," he replied, "but she's headed east, and so are we. Let's leave Oomak and Tuginana here, and take our boat out to meet her."

IT WAS an hour later that the *City of Spokane*, Yokohama to Seattle, clanged her engine room telegraph, and slid to a stop near the crazy looking little steamer that had so wildly waved to her. Her rail was crowded with questioning passengers, and a Jacob's ladder was dropped over her side. Williams was the first to reach the deck.

"It is mighty kind of you to pick us up," he said to the officer who met him at the rail. "I wonder if you will be good enough to tell me where you are bound."

"Seattle," replied the officer, staring at the bearded, charcoal-stained, rabbit-skin-clad scarecrow who spoke so perfectly.

The others climbed one by one over the rail, and the engine room telegraph clanged once more.

"Well, by George," remarked Thornton as he sorrowfully watched their handiwork drift slowly astern. "We made it at last."

"Indeed you did, old man," replied Parker. "And I didn't believe it possible. By Jove, I can get a cigarette now."

THE END

Explosions Caused by Machinery

ON A dry day, if the air is heavily laden with dust or any kind of finely pulverized matter the sparks of static electricity thrown out by the moving parts of machinery sometimes cause an explosion. Flour mills, dry cleaning establishments, coal mines and the vicinity of threshing machines are places where fires may result from these explosions.

Lindbergh's Great Partner

(Continued from page 12)

offer the least resistance to the wind, and fastened with steel connections at all points. Forward of the wings the fuselage is covered with a metal cowl, to protect the working parts of the engine. The fuselage itself is built of seamless steel tubing, covered with stretched fabric similar to that used on the wings. The horizontal rudders, or elevators, and the vertical rudder at the extreme rear of the fuselage, which operates precisely like the rudder of a boat, are of wood covered with fabric. Everything about the fuselage is streamlined, to give the least possible resistance in flight. The only exceptions are the nine cylinders of the engine, which require air resistance for cooling, the landing wheels, and five projecting tubes.

Three of these projecting tubes, bent at right angles and projecting above the center of the wings, are vents for the gasoline tanks, to prevent accumulation of vapor which might explode. Projecting more than two feet forward from the lower surface of the left wing is a slender, forked tube, the Pitot tube which actuates the speed indicator on the aviator's instrument board. And from the top of the fuselage, about a third of the way from the wings to the tail, a four-inch cylinder projects vertically into the air about a foot.

THIS cylinder is the housing of the driving mechanism of the earth inductor compass, which will be described later. It carries at its upper end a tiny windmill which, at a speed through the air of seventy miles an hour or more, generates enough power to run a small dynamo concealed inside the fuselage.

The heavy wooden "legs" to which the landing wheels are attached are streamlined, as are the bracing struts which hold them in place. They are hollow for part of their depth, to receive the plungers attached to the independent axles of the wheels. These plungers act on concealed springs when the plane lands and the wheels themselves are cambered, or set at an angle inclined inward from the vertical, to prevent undue spreading when alighting or "taxiing" over rough ground.

So much for the plane itself, but a plane is useless without an engine, and the engine of Lindbergh's plane is as up to date as the plane.

In two important particulars this Wright Whirlwind J-5 motor represents an advance over anything which was in general use when the war ended. It is air-cooled, and its nine cylinders are arranged in a circle around a central crank shaft, thus reducing the length and weight of the shaft and crank case. This type of design, in which the cylinders are stationary, is known as a radial engine.

Constant improvements have made the Wright Whirlwind the most dependable aviation motor now in use. It is standard equipment on twenty-five or more makes of airplanes. It supplied the motive power for Commander Byrd's flight across the North Pole, and for Chamberlin's flight to Germany in the Bellanca monoplane. And it took Lindbergh more than 3600 miles without missing a stroke in any of its nine cylinders.

As the shortening of the crank shaft and its housing reduces the weight of the engine itself, air-cooling reduces the plane's load still further, by doing away with the radiator and its contained water. Moreover, all danger of freezing is eliminated.

In Lindbergh's engine the rush of the machine through the air, at from seventy to 135 miles an hour, produces a current of air which is intensified by the back-wash of the propellers, and which carries off the heat generated by the explosions in the cylinders. The cylinders themselves are machined from steel forgings, with external annular or ringlike fins at carefully-determined distances, to give the largest possible radiation (Continued on page 124)

Lindbergh's Great Partner

(Continued from page 122)

area with the least air resistance. The cylinders have a bore of 4.5 inches and the piston stroke is 5.5 inches, the nine giving a displacement of 788 cubic inches, which produces about 225 horsepower at 1900 revolutions per minute at sea level. At high altitudes the power is reduced.

Lindbergh's engine weighs approximately 500 pounds, equipped and ready for operation, or just over two and a half pounds per horsepower. Lighter engines have been built, Liberties have produced above 500 horsepower with an engine weight of 880 pounds. But there was the additional weight of the water-cooling system to be added, so that in practice Lindbergh's engine is about as light as any which have proved able to stand the strain of continuous flight.

The outside diameter of the engine is forty-five inches; its length from the front of the propeller hub to the point of attachment with the fuselage is only twenty-seven and one half inches, though the housing of the crank case projects six and one half inches further back. An ingenious triple-action carburetor, with three barrels supplied by a common float, feeds gasoline to the cylinders through three three-way manifolds, each serving three cylinders. The exhaust manifold is circular and leads down to a point directly below the forward end of the fuselage. All of the working parts of the engine except the pistons are machined from special alloy steels; the pistons are of cast iron. The crank shaft is mounted on ball bearings. Ignition is by a dual magneto system.

THAT is the engine which pulled Lindbergh and his plane 3647 miles, from New York to Paris, in a single flight, in 33½ hours, an average of 108.7 miles an hour on 438 gallons of gasoline and 11.6 gallons of oil. That figures out a gasoline consumption of 12.8 gallons an hour, or about 8.4 miles to the gallon, a record which would rejoice the heart of many a driver of a high-powered automobile. And the oil consumption is even more remarkable, 300 miles to the gallon, or more than seventy-seven miles on a quart of oil. The average speed of the engine, Lindbergh reported, was 1900 revolutions per minute.

To drive the engine, keep the plane in equilibrium in the air, and find his way across the trackless ocean, Lindbergh had at his command a collection of controls and instruments, most of them common to all airplanes, but two at least as unfamiliar to the ordinary groundling as they are to most airmen. Those two are the earth inductor compass and the periscope.

Fixed in the little window over his head, which gave him sight and ventilation, Lindbergh had a magnetic compass, but the magnetic compass alone is of little use in the air. Not only does its successful use require an exact knowledge of the navigator's position and the variation of the needle from the true north to be expected in that latitude and longitude, but the needle, in flight, is never constant to the pole.

The earth inductor compass, invented within the last five years by Maurice M. Titterington, chief engineer of the Pioneer Instrument Company of Brooklyn, is the latest and most useful of all the aids to aerial navigation. Its principle is based upon the fact that the earth's revolutions in space generate electromagnetic lines of force which flow in a north-and-south direction, from pole to pole. The earth is, in short, a huge electromagnet.

As every student of electricity knows, a dynamo consists of a coil of wire, or armature, rotated at right angles to the lines of force of an electromagnet, or field. It follows, then, that if a coil of wire is rotated rapidly enough at the proper angle to the earth's magnetic field it will become a dynamo and generate current. This current will flow (Continued on page 136)

Lindbergh's Great Partner

(Continued from page 124)

through the coil in the same relation to its poles as does the magnetic current in the field, and it can be taken off from the armature poles by means of brushes and led through wires to perform whatever work it is capable of.

An interesting fact not often remembered is that the angle at which the brushes make contact with the armature poles determines the potential of the transmitted current. And this is the fact on which the earth inductor compass is based.

Below the little windmill sticking out of the fuselage, already referred to, is a small armature, revolving on a vertical axis and hung on gimbals so that it is always at right angles to the earth's magnetic field. The little windmill supplies the power to keep it rotating. The very faint current taken off from this tiny dynamo, of which the earth itself is the field, is carried to a galvanometer or indicator mounted on the instrument board in front of the pilot. When the brushes are set so that no current whatever is being taken off the generator, the galvanometer needle points to zero.

In Lindbergh's machine the brushes are set so that the highest output of the generator is obtained when the brushes are respectively north and south of the armature poles, and the potential is zero when the brushes are east and west.

NOW, to find out the direction in which he was flying, Lindbergh had recourse to the third element of the combination of devices which make up the inductor compass—the controller. This is a dial set horizontally near his right hand, with a little crank projecting from its center and an indicator needle fastened to the rim of the case. On the rim are marked the points of the compass, with figures corresponding to those on the galvanometer, north being indicated by zero. This dial is mechanically connected with the generator brushes, by a flexible shaft.

The aviator turns the crank of the dial, rotating the brushes upon the poles of the armature. The little galvanometer needle creeps back to zero as the brushes reach the east-and-west position. But the dial has moved, with the crank, precisely the same number of degrees and minutes as the brushes themselves have moved, and the indicator on the dial points to the exact point of the compass toward which the plane is heading.

It sounds complicated, but is one of the simplest devices possible, and its accuracy is far greater than that of a magnetic compass. Its variation is seldom more than three or four minutes of circumference from accuracy. Small wonder that every time Lindbergh spoke of his plane he praised this compass which enabled him to cross the coast of Ireland within three miles of the point at which he had aimed.

The other innovation used by Lindbergh to aid him in his flight, and one which excited the derision of many airmen—before the flight—is the periscope. This is simplicity itself. Imagine two metal boxes, each about the size of a common brick though somewhat longer, each open at one end so they will telescope one over the other. Now set a mirror at an angle of forty-five degrees in the end of each part, cut an opening opposite the mirror, slide the two parts together so that one mirror faces forward and the other backward, and you have the essentials of Lindbergh's periscope. It is fastened to the upper left corner of the instrument board of the *Spirit of St. Louis*, so that the aviator can look at one mirror and see there the reflection of whatever is reflected upon the other mirror, when the outer end of the periscope is extended beyond the side of the plane. That is all there is to it. It was added to the plane as an afterthought, when it was realized that the inclosed cockpit would give the aviator no opportunity to see (Continued on page 126)

Lindbergh's Great Partner

(Continued from page 125)

ahead of him. Crossing the ocean that made little difference, but over land, and especially in landing, ability to look ahead was important.

The rest of the apparatus in the cockpit of Lindbergh's plane is part of every airman's equipment. Chief of the controls is the "joy stick," the lever which controls the ailerons and the elevators. Pull the joy stick backward and the elevators at the tail of the plane turn upward, the machine runs push it forward and the descent begins. Move the joy stick to the right and it simultaneously depresses the left aileron and lifts the right one, banking the plane to the right. A perfectly-balanced plane will fly in a straight horizontal line, except for wind drift, without the pilot's hand upon the joy stick. Constant consumption of gasoline, reducing the head load and so changing the balance, made it necessary to equip the *Spirit of St. Louis* with a device whereby the elevators could be held in a slightly deflected position, which could be changed from time to time, in order to let Lindbergh take his hand off the joy stick long enough to set his compass control, eat a sandwich, mark his chart or make entries in his log. This device is a lever just under the instrument board, at the pilot's left which can be locked into any one of a dozen positions, much as the emergency brake of an automobile is locked. A third lever in the little cabin, close to Lindbergh's left hand, is the gasoline throttle controlling the engine speed. And under his feet is the rudder bar, a pressure of the right foot moves the rudder to the right and turns the plane horizontally in that direction, and vice versa.

IN FRONT of the pilot, below the instrument board, are cocks for tapping the gasoline tanks as required. On the instrument board, in addition to the periscope and compass indicator, the clock, engine primer lever for controlling the gas mixture at the carburetor, ignition switch and oil pressure gage, which are similar to those used in automobiles, the essentially aviation indicating devices are a tachometer, an inclinometer, a bank and turn indicator, an air speed indicator and an altimeter.

Lindbergh told the reporters in Paris that he rose to a height of ten thousand feet to get above a sleet storm, which threatened to bring him down because of the weight on his wings. How did he know he went up ten thousand feet? The altimeter is the instrument that tells the story of height. It is an aneroid barometer, the principle of which is that if you exhaust most of the air from a thin metal box with flexible and corrugated sides, then seal the box, every change in air pressure on the outside of the box will cause the sides to bulge outward, if the air pressure is reduced, or to bulge inward if it is increased. By connecting the sides of the box with a delicately adjusted needle indicator, the change of air pressure from one elevation to another may be indicated.

The sealed barograph which Lindbergh took with him to provide indisputable proof that no landing was made between New York and Paris, is merely an aneroid barometer connected with a clockwork mechanism which records on a strip of paper every change in barometric pressure and therefore every change in altitude over a given period of time.

An interesting application of a principle discovered more than two hundred years ago by the French philosopher Pitot is the air speed indicator. Pitot found that if one arm of an L-shaped tube was placed horizontally in a stream of water, the height of the water in the vertical part would increase in a certain ratio to the speed of the flow. The same is true in a current of air, the pressure in a tube around which an air current is flowing, increasing in proportion to the speed of the air current. So the straight end of the long Pitot tube which projects forward from under the plane's left wing, far enough forward to be out of the propeller's blast, is exposed to a current of air whose speed is precisely that of the plane itself as it rushes through the air. Midway between this opening and the tube's other end is a flexible diaphragm which moves with the increase or decrease of pressure, and actuates the dial in front of the aviator which indicates his speed through the air in miles per hour.

The other device to aid the pilot in determining his speed is the tachometer, which operates like the speedometer of a car, except that it shows engine revolutions per minute instead of miles per hour. Eighteen hundred a minute was the maximum reached by Lindbergh's engine, when he was climbing out of the sleet storm off Newfoundland.

THE remaining two instruments on the board, the inclinometer and the bank and turn indicator, complete the pilot's information. The inclinometer tells whether he is ascending or descending; also whether he is tilting to the right or left. It is a highly necessary instrument for night flying, when no horizon is visible; for it is a curious fact that airmen are unable, under such conditions, to tell by their own senses whether they are right side up. The inclinometer works on the principle of a spirit level. A horizontal tube of an alcohol and glycerine mixture contains a bubble that shows by its position whether the plane is tilting sideways. Below it on the instrument board is visible one arm of a liquid filled U-tube. The liquid level, changing with each dip or upward tilt of the plane, shows the fore-and-aft inclination from the horizontal. The bank and turn indicator, like the first of the inclinometers, shows whether the plane is flying on an even keel by means of a spirit level, and it still registers zero, its central position, when the pilot banks at the correct slant to distribute the combined stream of centrifugal force and gravity evenly over the plane's wings. Its turning indicator, an application of the gyroscope, tells the aviator flying over unmarked spaces, like the prairie or the sea, whether his machine is turning to right or left without tilting.

The sensitive element of the turn indicating mechanism is a small air-driven gyroscope, operated by the pressure obtained from a venturi tube. A venturi tube is one constructed at some point in its length and tapering or flaring outward in both directions. It serves to intensify a low pressure of any fluid passing through it to a much higher pressure at the point of constriction.

Through the venturi tube a powerful stream of air sets the little gyroscope revolving. Once it is set spinning, it will continue to rotate in a given plane so long as the motive power persists and regardless of any change in position of its supporting structure. So the little gyroscope inside of the turn indicator keeps merrily on its straight-ahead way, no matter how much the plane may veer to the right or the left, and the pointer on the turn dial stays right along with its parent gyro, telling the aviator instantly whether he is steering a straight course or not.

Is it any wonder that Lindbergh and "We"? Almost as complex as his own human structure, many times more sensitive in many respects, as delicate as a woman yet stronger than the strongest man, with powers of endurance and resistance which humanity has never even approached, the *Spirit of St. Louis* carried him through space with uncanny precision and terrific speed. How can he help feeling that his plane is a friend, a comrade, a personality?

Thrillers Defy Gravity

(Continued from page 39)

cars are equipped reduce the shock of collisions.

With war in progress in several parts of the world, this season has brought a revival at the parks of the "cyclorama." An elaborate mechanical portrayal, on a 315-by-50-foot screen, of the Battle of Chateau-Thierry has been opened this year by Jarvis, at Luna Park, Coney Island. The illusion of distance and perspective is obtained by using six painted screens, at various distances from the observer. Small parts in the cyclorama, such as the motor trucks, tanks, and a bridge are movable and the bridge drops out of sight in a cloud of steam when "blown up," accompanied by the report of a shot gun fired in a barrel. Electric flashes, jets of steam, a set of drums, rifles and a machine gun make the battle realistic. Lecturers explain the engagement, as it progresses from sunrise to sunset, in about thirty minutes quite like the "Johnstown Flood" of former years, probably the best known example of this type of entertainment.

THE extremes to which amusement park promoters will go to attract public attention are exemplified in the "Surf Bath" at the Palisades Amusement Park, Fairview, N. J., in which plungers at one end of a large pool churn the salt water by lifting heavy blocks up and down, behind a guard screen, producing eighteen-inch breakers, that sweep the 300-foot pool, and wash a sandy shore at the opposite end. The pool is refilled daily with filtered ocean water, pumped ten miles through a pipe, from near the Battery, New York City. The Surf Bath, according to Nicholas M. Schenck, its builder, has accommodated 11,000,000 people in eighteen years.

The red letter days for the concession parks, strangely enough, are not the holidays, but the dates before the holidays. The three big summer holidays—Memorial Day, Independence Day, and Labor Day—provide variety of activity in themselves, but the nights before those days, when people are relaxed in the realization that they do not have to report for work the next day, bring to the amusement parks the biggest throngs of the year.

Controlling Radio Volume

(Continued from page 84)

how much you cut down the audio amplification, the detector tube is bound to be overloaded on all strong signals, resulting in distortion.

Turning down the audio amplifier tubes by a rheostat will decrease the volume, but the situation is not the same as for the radio-frequency tubes. The audio tubes carry much heavier currents, particularly the power tube, and when you cut down the filament emission by dimming the filaments you unbalance the whole system with disastrous results as far as quality is concerned. Controlling the volume by dimming the detector tube is equally bad.

Connecting a variable high resistance across the primary or secondary winding of either the first or second stage audio transformer will give good volume control on small sets using not more than one stage of radio-frequency amplification. The best place for the variable resistance is across the secondary winding of the first stage audio transformer, between the G and F terminals of the instrument. With many types of audio transformers, the extra load across the secondary changes the amplifying characteristics and so causes distortion.

With cheap, old style transformers, the result may be an improvement, but with modern instruments the effect is likely to be bad.

ENGINEERS SURVEYING for a new railroad connecting Siberia with Turkestan have dug up the skeleton of a gigantic quadruped said to have lived three million years ago.

Even Worms Solve Puzzles

(Continued from page 31)

the answers. This disposed of the telepathy hypothesis. Finally came the true solution. As soon as the experimenter gave a problem, he involuntarily bent forward slightly to see what the horse would do. Then, when the right number of taps had been given, he straightened up the least bit. The horse, on the lookout for this movement, responded by ceasing to tap. In other words, while the trainer thought he was teaching the horse arithmetic and language, he was really teaching him merely a simple code of when to start tapping and when to stop!

So far as is known, all "problem solving" of a complicated type by the lower animals is explainable in similar terms. The great body of experimental evidence shows that the mentality of animals is of very primitive order. That animals do solve some simpler problems, however, has been demonstrated frequently.

TAKE the matter of opening a door latch. This task is easy for the monkey, and is well within the scope of the raccoon, porcupine, cat, dog, rat and even birds, provided the latch is operated by a string. The animal may be placed either inside a box, usually with food outside, or outside the box with food inside. He does not find the latch and solve the problem at once, of course. Instead, the first success is somewhat of an accident. The animal attacks the barrier with claws and teeth and unfastens the latch by chance. This tells him where to concentrate his efforts, and so each successive attempt becomes easier.

After learning this trick do you suppose the animal *understands* about latches? Does he know how they work? If we move the latch to another part of the door we find that he goes to the same spot as before, scratching, not at the latch, but at the place where the latch used to be.

New types of problem boxes are constantly being devised. One of these, a product of the laboratory at Columbia, is illustrated on page 33. This box, so perfect mechanically that it operates without sound, has an outer cage to keep the animal on the table and an inner cage containing food. The door of the food cage, held shut by a magnet, opens when the rat steps on a trigger set in the floor to the rear. Even when he does this, however, he has no way of knowing that the door is open until he happens to approach it again. This problem, a difficult one, is "learned" when the animal rushes directly to the trigger and thence into the food cage full speed. White rats on the average require about sixty trials to learn this act. Some of the brightest require less than half that many, while the dullest require more than a hundred. Animals vary in intelligence just as we do.

SUPPOSE we make a box so complicated that the animal is called on (1) to push in a plug, (2) to pull a string, (3) to shove down on a cross bar, and (4) to lift a latch. If he mixes up the order the door will not open. This is a neat problem for anyone, but the monkey and raccoon can do it. Monkeys especially, because of their great manual dexterity, show much skill at this sort of problem.

From the moment of birth, and long before its eyes are open, even a baby white rat is a going concern, crawling about, washing its face and pushing objects out of the way with its feet. Why? If it cannot see nor hear, where does the stimulus come from? The answer is that it must come from inside, and it is this inner compulsion that scientists call a *drive*. But instead of being mystical, it is more likely the result of an internal physical condition, such as an empty stomach.

Psychologists often have wondered which of the various drives—hunger, sex, fatigue, and so forth—play the greatest part in controlling the animal's life. Which is hardest to overcome? Which produces the greatest external activity?

To test this question at Columbia an electric grid is placed between the animal and the object of its search—either its food, its nest, its mate, or its young. The electric shock, mild but always the same, serves as an obstruction. The question is, then, which drives will overcome the obstruction most frequently?

Results thus far are in favor of hunger—within certain limits. Rats starved for twelve hours, for instance, will cross the grid oftener than those starved only six hours, and so on up to four days. After that, for some strange reason, the desire for food seems to weaken. The rat will cross less often on the fifth day than on the fourth. In fasting experiments on humans, physiologists have shown that we also suffer more during the first few days, and gradually lose appetite the longer the fast.

The maternal drive in the rat is weak. The mother refuses to cross to her young, but will go over immediately to satisfy her hunger. Preliminary results on the sex drive at the Columbia laboratory indicate that it lies much nearer to hunger than to the maternal impulses. Similar tests are planned for monkeys.

THE rails of a car track are parallel, but to the human eye they seem to converge—which is just one of a hundred examples to show that human sense organs are subject to illusions. A vertical line looks shorter than a horizontal line of the same length crossing its center. If two equal arcs of a circle are placed one above the other, the lower one seems larger. Philosophers question whether we can ever know the world as it really is, since our sense organs themselves are untrustworthy.

Animal psychologists have begun to wonder whether the eyes of other species are subject to this deception. Does the bird, for example, whose eyes are much like our own, have a similar defect of vision? Already enough facts have been gathered to show that the domestic hen and the dove, at least, have many of the same illusions that we have.

In an investigation by Prof. Geza Revesz, of Goettingen University, Germany, two arc-shaped areas of cardboard of different sizes were cut out. On the smaller piece free grain was sprinkled but on the larger piece the grain was glued down. A hen was then admitted, and after several hundred tests learned to peck at the smaller area only.

THEN the illusion test was made. Two arc-shaped cardboards, this time of exactly equal size, were placed one above the other so that to the human eye the upper one seemed smaller. Free grain was placed on both. Unless the hen was subject to the arc illusion the arcs would look exactly alike. Now, did the approaching hen peck the first grain she came to? She did not! She reached over, neglecting the grain beneath her feet, and pecked from the top arc of the pair which looked smaller, though the two arcs were the same size exactly!

Tests on the ring dove now in progress at Columbia center about the familiar Muller-Lyer illusion which causes two lines of equal length to appear of different lengths when angles opening in opposite directions are drawn at their extremities. In this experiment the animal is confronted with a choice of two lines, one longer than the other. If he responds correctly he is fed, if wrongly, he steps on a charged grid and receives a light electric shock. After long training, the bird is able to select the shorter

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Even Worms Solve Puzzles

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of two lines quite accurately. The lines are then removed, the Muller-Lyer figures substituted, and we watch to see whether he chooses the line that seems to be shorter to us. So far results indicate that he sees the illusion as we do, but a final answer must wait until the research is completed.

This apparatus is also used to determine whether birds can distinguish between circles, squares, and triangles of about equal area. For the crow the answer is yes—but the crow has unusually sharp eyesight. Other birds, such as the ring dove and hen, do not discriminate between forms so well, unless there is also a difference in size.

The color vision of birds is so good that they seem able to distinguish about the same range of colors as man himself. Evidently the gaudy plumage of the male peacock and bird of paradise is therefore not wasted, after all; probably fine feathers help out in bird courtships as well as in human! This is the more remarkable in view of the fact that most of our domestic animals, such as the dog, cat, cow and probably the horse, are color blind. With the exception of monkeys, in fact, it seems that very few of the mammals see color. The world to them, most likely, is plain black, white or gray.

Hook Your Phonograph to the Radio Set

(Continued from page 64)

operation will enable you to build the whole amplifier as a self-contained unit in a compartment of the phonograph cabinet, or if you have a small phonograph the amplifier can be fitted into a box and placed in a near by closet where it will be out of sight and out of the way.

Those of you who have not yet brought the audio amplifiers in your radio receivers up to date will find that Fig. 4 will show you how to do this with the least possible trouble. Remember that in remodeling your present set you will need to install new binding posts only when similarly marked posts are not already in the set.

Connecting the amplifier of Fig. 4 to any standard radio detector set presents no difficulties. Simply connect the two wires from the one tube set that ordinarily connect to the headphones to a plug instead, and insert the latter in place of the plug from the phonograph pick-up device. Be sure to try reversing the two wires and choose the polarity that gives the best tone quality.

BY SUBSTITUTING a double circuit jack with four connecting prongs instead of the open circuit jack shown at the input end of the amplifier circuit and connecting the center two prongs in place of the headphones of your radio set, you can eliminate one plug. With the pick-up device in place the amplifier will be connected to the phonograph. When it is pulled out the amplifier will automatically be connected to the radio detector circuit.

Under no circumstances try to operate the amplifier of Fig. 4 with a radio set that includes any audio amplification. Such an attempt to obtain extraordinary volume will not be successful, for squeals and howls are sure to result.

If you desire additional information on the circuit or the types of phonograph pick-up devices or other apparatus approved by the Popular Science Institute of Standards, address your letters to: Radio Editor, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York City.

AMERICAN ships plying the Great Lakes carried eight million more tons of freight last year than ever before. The net total for the year was 121,259,302 tons.

On the Sea in a Cable Ship

(*Continued from page 23*)

dragging anchors—the pet aversion of cable men—must be guarded against.

But the most thrilling task of all is beaching the cable at the end of the voyage. For the big ship cannot approach closer than a mile from the beach at best—sometimes three miles is the limit. From that distance the heavy line, weighing fifteen to twenty tons to the mile, must be carried through the breakers.

It is up to the chief engineer to decide how this is to be done. If the landing is near civilization, where modern machinery is available the task is comparatively simple. In landing the Azores cable at Rockaway Beach, N. Y., and again in landing the new high-speed North Atlantic cable from London to New York last year, the end of the cable was transferred to a light-draft auxiliary vessel which carried it to within a quarter of a mile of the beach and anchored. There a tow rope was attached to the cable, and a small boat carried the rope to shore. On the beach a winch mounted on a motor truck hauled in, and the cable, buoyed by barrels at intervals of thirty feet, floated to shore.

AT OTHER times, however, a landing must be made on some wild and rocky key in the South Seas, or on the edge of an African jungle inhabited by hostile savages. Then there is excitement aplenty. No end here perhaps, except the sleek backs of savages who must be cajoled and bribed, probably with bright cloth and beads, to wade out up to their necks and pull the cable ashore. More than once rockets have been employed to hurl a towline over the surf. At Fayal in the Azores oxen were hitched to the cable. And in one penal colony reformed cannibals and black murderers were drafted to do the tugging. Dangers are ever present. Just twenty years ago the chief engineer of the Colonia was devoured by cannibals near the town of Mombasa in East Africa. It takes a cool head and a stout heart to be a cable man.

And when the cable is down at last the task has only begun. There are a hundred ways in which a cable may be damaged or broken, despite its armor. Icebergs may grind it asunder. Hidden rocks may rasp and wear through it. Trawlers and the dragging anchors of rum ships and other craft frequently catch and break it. In one damaged cable a shark's tooth was found imbedded. One break in the United States-Alaska cable was caused by a whale, whose huge carcass was found entangled in it.

Worst of all is the little teredo boring worm that eats wharves and pilings. In tropical waters where these pests abound, the cable is so heavily insulated that it is thick as a python, yet the teredo gnaws through even this heavy covering. To defeat the teredo, the copper cores of cables in tropical waters often are surrounded by shielding walls of brass.

OF ALL the strange mishaps that have befallen cables, the classic example occurred a few days after the first international cable was laid, in 1850, between Dover, England and Calais, France. A French fisherman, by chance, hooked up the cable. Thinking it might be some strange species of eel, he hacked it with his knife. The shining copper looked to him like gold so he chopped off as much of the cable as he could and jubilantly sailed for home!

The accuracy with which experts at a shore station can locate breaks in a cable and place a finger on the exact trouble spot is almost uncanny. It is done by means of the Wheatstone bridge, an instrument which measures electrical resistance of a conductor. Since the exact resistance for every mile of cable is definitely known, measurement of the total resistance of the cable to the point of breakage tells how many miles from shore the trouble lies. Thus, if the normal resistance of a cable is two ohms to the mile, and the measurements show a total resistance of 2730 ohms, the cable men know that the break will be found somewhere in the 1365th mile out. A repair ship hurriedly steams for that spot.

IMAGINE, this time, that you are aboard the Western Union repair ship *Lord Kelvin*, one of the largest in service, at the moment a message flashes in that the North Atlantic cable is out of commission. Within a few hours you are steaming from port, headed for a charted dot in the ocean. Arriving there, an 1800-pound buoy, flagged and lighted, goes overboard and is anchored to mark the place. The work of "fishing" begins. If the water is not too deep, a grapnel resembling a five-pronged anchor is used as the "fishhook." If the depth is a mile or more, a special grapnel is used which, once it hooks the cable, cuts it apart and at the same time clutches one of the severed ends and brings it to the surface.

On this job an ordinary grapnel is used. Back and forth, in a zigzag over the line of the cable, steams the repair ship, dragging the grapnel over the sea floor, while every pull on the towline is recorded on the dynamometer scale. All at once the pointer on the scale leaps upward. The cable is hooked. Then it's "Stop her!" and heave in the towline. Powerful winches haul the cable up to the ship, then two men, slung over the side in bosun's chairs, fasten it securely with stopper chains on each side of the grapnel. Between these stoppers the cable is cut.

Electricians in the testing room begin the search for the flaw. The side nearest land is found to be sound, so it is buoyed and dropped overboard. Then the ship steams ahead, hauling in the other end. Soon the electricians report that the flaw has passed inboard. It is found to be a deep gouge in the cable armor as if bitten by some sea monster. Constant chafing by a hidden rock has worn through the covering penetrating to the copper core. Quickly the damaged part is cut out and a new section spliced in its place.

THIS done, your ship returns and picks up the buoyed end. Carefully the two ends are soldered and spliced together, and at last the cable, whole once more, is flung back to the depths.

The advance of cable transmission is keeping pace with the newer developments of radio. The cable has certain natural advantages which make this possible. It affords secrecy of messages; it is free from static and other interference encountered in the ether; and it provides a permanent record of every message sent. Moreover, amazingly little power is required to operate a cable. Ordinarily the voltage needed for signals across the ocean is about fifty volts.

As for speed of transmission, the recently achieved capacity of 2500 letters a minute is only the beginning, in the opinion of cable experts. "Permalloy cables may do even 5000 letters a minute," says one cable company executive.

At that rate, should every one of the world's 500 submarine cables be permalloyed, 2,500,000 letters could flash their way under all the oceans every minute, bearing messages.

Hawaii's New Quake Observatory

EARTHQUAKES in the Pacific Ocean will be recorded more efficiently with the new earthquake observatory of the U. S. Coast and Geodetic Survey at Honolulu, Hawaii. The instruments are placed in one of the buildings of the University of Hawaii.

Each of Us Has 40 Slaves

(Continued from page 130)

this power operated pumps it could pump all the water of the Mississippi River into a tank on top of Washington Monument in less than twenty four hours.

Occasionally a railway locomotive is given 100 loaded freight cars to pull. Suppose that such a train is nine tenths of a mile long, and that the locomotive develops 1,000 horsepower. At that rate, a locomotive developing as much power as is developed in the United States could pull a freight train of 100 million cars. And from the locomotive to the caboose, the distance would be equal to more than three and one half times the distance to the moon.

Automobile manufacturers alone are adding more than 500,000 horsepower a day to our grand total, and in countless other factories still other sources of power constantly are being developed.

LABOR, in the old sense, is rapidly disappearing. Already, most drudgery is eliminated. Watch a skyscraper being erected. Steam shovels excavate. Machines mix the concrete which is handled on trucks or in elevators and poured into molds. Steel beams appear on huge auto trucks. Derricks drop their cables down. Engines whir and the beams soar aloft. They are lowered into place while the workmen signal by waving their hands. Bolts are thrust through ready-made holes. Engines roar. Red hot rivets are thrust into place and riveted with pneumatic hammers.

In a huge factory a ladle containing tons of molten metal is swung aloft. It pours. The metal is poured, and a casting is taken from the mold. The machine work is performed. The finished product is placed upon a flat car and delivered 1,000 miles away to men who push buttons and throw levers, although the casting may weigh a score of tons. Not a single back has been strained. No man has toiled as men labored a hundred years ago.

An Englishman, visiting such a factory, asked his guide:

I say. Why don't you employ girls at these tasks?

Calloused hands are not exactly a rarity these days, yet for every man whose hands are calloused by labor there is one whose callouses have been caused by golf clubs. The time may come—in America—when calloused hands will belong exclusively to wielders of the implements of sport. We are becoming a nation of investors and button pushers. We sit behind steering wheels. We push levers and pull them. We turn dials and throw switches. In our homes, we turn on the water instead of going to the pump. We use vacuum cleaners, automatic refrigerators and automatic furnaces. We freeze ice cream without turning a crank, and boil water by pressing a button. Sewing machines and pianos are run by motors. Talking machines change their own records, wind themselves, and automatically stop. Clocks are wound by electricity.

MOVING stairways and elevators carry us up and down in our buildings. We have our pictures taken by dropping a coin in a slot. We fly. We talk across the ocean. We actually see by wire and by radio. We dive beneath the water and remain dry. We float upon its surface and are propelled by the power of an army. In none of these things is a strong back or a muscular arm essential.

This era of power of automatic machinery of the elimination of labor has just begun. Fifty years ago it had hardly more than started. Now every day sees something new to make our lives still easier.

Where will it end? Will the time come when work will be eliminated from the earth by the power of our machines?

Why Don't You GET INTO THIS BIG PAY FIELD

$3500 to $10000 a year

Ill train you at home

L. L. Cooke

Snap out of that poor-pay, no-future job! Quit wishing for Big Money and go get it! Jump into Electricity! Become a Cooke Trained Big-Pay Man like my ten thousand other "boys" who earn $12 to $30 every day in the same eight hours that pay some men $4 to $5 a day. I'll show you a way you'll quickly adopt and never forget!

"Schooling" Not Necessary

You don't have to be a college Man. You don't have to be a High School graduate. You don't have to be a mechanical genius. You don't have to be a wireless operator. You don't have to be a telegraph operator. You don't have to be a telephone man. You don't have to be a motion picture operator. You don't have to be a railroad man. You don't have to be a chauffeur. You don't have to be a garage man. You don't have to be a battery man. You don't have to be a farmer. You don't have to be a blacksmith. You don't have to be a carpenter. You don't have to be a painter. You don't have to be a plumber. You don't have to be a bricklayer. You don't have to be a machinist. You don't have to be a tinsmith. You don't have to be a boilermaker. You don't have to be a sheet metal worker. You don't have to be a pipefitter. You don't have to be a steamfitter. You don't have to be a toolmaker. You don't have to be a die sinker. You don't have to be a pattern maker. You don't have to be a molder. You don't have to be a foundryman. You don't have to be a machine operator. You don't have to be a lineman. You don't have to be a cableman. You don't have to be a substation operator. You don't have to be a powerhouse man. You don't have to be a telephone man. You don't have to be a telegraph man. You don't have to be a railroad man. You don't have to be a chauffeur. You don't have to be a garage man. You don't have to be a battery man. You don't have to be a farmer. You don't have to be a blacksmith. You don't have to be a carpenter. You don't have to be a painter. You don't have to be a plumber. You don't have to be a bricklayer. You don't have to be a machinist. You don't have to be a tinsmith. You don't have to be a boilermaker. You don't have to be a sheet metal worker. You don't have to be a pipefitter. You don't have to be a steamfitter. You don't have to be a toolmaker. You don't have to be a die sinker. You don't have to be a pattern maker. You don't have to be a molder. You don't have to be a foundryman. You don't have to be a machine operator. You don't have to be a lineman. You don't have to be a cableman. You don't have to be a substation operator. You don't have to be a powerhouse man. You don't have to be a telephone man. You don't have to be a telegraph man.

Electrical Men in Demand

Electricity is the one great profession which offers you quick success. Trained Electrical Men are in demand everywhere. Big jobs paying $3,500 to $10,000 a year are waiting for them. Electrical Contractors, Electrical Engineers, Electrical Salesmen, Electrical Foremen, Electrical Inspectors, Electrical Wiremen, Electrical Linemen, Electrical Cablemen, Electrical Substation Operators, Electrical Powerhouse Men, Electrical Telephone Men, Electrical Telegraph Men, Electrical Railroad Men, Electrical Chauffeurs, Electrical Garage Men, Electrical Battery Men, Electrical Farmers, Electrical Blacksmiths, Electrical Carpenters, Electrical Painters, Electrical Plumbers, Electrical Bricklayers, Electrical Machinists, Electrical Tinsmiths, Electrical Boilermakers, Electrical Sheet Metal Workers, Electrical Pipefitters, Electrical Steamfitters, Electrical Toolmakers, Electrical Die Sinkers, Electrical Pattern Makers, Electrical Molders, Electrical Foundrymen, Electrical Machine Operators

Is Your Home Safe From Fire?

(Continued from page 67.

protection is increased with the addition of metal lath. All the numerous varieties of vegetable fibers employed in insulation, from cork to flax, are subject to charring with sufficient heat, but they are not apt to flame or contribute to a vigorous fire. If you surface these materials with plaster or stucco, you kill two birds with one stone. The exact degree of compromise between insulation and fire security depends on circumstances, including the owner's need or preference for one thing rather than another. Among the factors to consider are climate, type of house and local hazards. Is there fire protection in your community? A neighbor's roof may be a pertinent factor.

What has a neighbor's roof to do with planning my house?

IF THE neighbor's roof is covered with wood shingles, it may well decide you to take greater precautions in the make-up of your dwelling. Wood shingles are barred in many cities and towns as a general fire menace. They imperil not only the individual dwelling when ignited by chimney sparks, but may spread conflagration to all neighboring houses, especially when a high wind scatters them as flying firebrands. An old neglected wood shingle roof of warped, split, fuzzy and decayed units is most dangerous because it is most likely to "catch" with a vagrant chimney spark. There is relative safety in having the best grade of quarter sawed shingles which do not warp and split in laying them securely, and keeping them in good repair.

Are asphalt shingles any more fireproof than wood?

Probably not if subjected to a good hot blaze. The asphalt will melt and burn along with its felt base. However, the mineral surfacing of these shingles does not encourage chimney sparks and in case of a real fire the units do not fly about like wood. Asphalt roofing may have an asbestos base, which is an improvement on felt. Perhaps the best use of asphalt is in strip shingles, which are surfaced electrolytically with a coating of pure copper. These are entirely proof against fire from above, while they would resist for a long time, if not indefinitely, the outbreak of an interior fire.

Is not roofing materials are completely fireproof?

ASBESTOS shingles, copper shingles, slate, burnt clay tile and concrete tile, sheet copper and zinc, not to mention tin. Among these there is a question of relative durability in long exposure to the elements. For example, unglazed clay tile will not stand a wet climate, tin rusts, and copper may be attacked by salt air and sulphurous gas. Thickness is also a factor in security. Asbestos shingles laid with the generous overlap of the rectangular or American style are obviously safer than when placed in the skimpy diagonal method. Heavy slate will crack and fall less easily in a fire than thin slate. All these materials call for a sheathing of tongue-and-groove boards nailed to rafters and a layer of roofing felt or asphalt roll roofing, which makes the job air-tight and insulates against heat and cold. Insulation is needed for a surface of metal or mineral that readily transmits variations of temperature. Besides sheathing and felt, a base of wooden strips is required for certain kinds of tile.

How about the chimney?

It is the most vulnerable part of the average dwelling. Chimneys, along with heating and cooking apparatus connected to them, are responsible for the greatest number of home fires in the United States. The chimney is a skeleton in our national closet. This article might logically have started with a discourse on the chimney iniquity, but since this aspect of fire hazard has been heavily harped on in the "firstly" of every fire sermon, I thought it better to make it "lastly." The chimney is indeed satanic in conduct. Amid the ruins of a burned-down house the chimney usually continues to stand with an air of stability and wronged innocence. People are deceived and say, "Well, the chimney was good anyway." They blame the house instead of the miscreant survivor. And they keep on building the same kind of houses and chimneys.

If were should we begin to build a chimney right?

AT THE foundation. If that answer sounds obviously silly, look at the other fact that not a few chimneys are seated on a couple of wooden posts or perched on a wooden shelf with a brace or two beneath. There should be a first-class concrete foundation, below the frost line if outside the house, and down to hard subsoil if within. Make the base a foot deep and a foot wider all around than the greatest dimensions of the superstructure, including open fireplace. However, it is not necessary to have a solid mass of masonry from base to ceiling of cellar. We may instead have two substantial columns connected above with a brick arch or with a slab of reinforced concrete. Thus we obtain light and headroom while saving space and material. Make the two columns hollow, so as to serve for ash dump for open fireplace and soot dump for furnace flue.

Can a well-built chimney be used to support floor beams?

Don't permit it. That is a common old-time and dangerous practice. Aside from fire risk, which is especially great when beams are built into the masonry, there is a question of unequal settlement when chimney and house are tied together. The chimney should stand independently of the house structure all the way from top to bottom, free to settle by itself if so inclined. No floor beams or woodwork should be closer than two inches from the masonry in general, or four inches from back of fireplace, and the space between should be filled with poor non-inflammable material like mortar waste, mineral wool or the like, resting on a metal strip nailed to bottom edge of beam. Thus there is a fireproof and flexible joint. A joint of similar effect but also water-tight is obtained at the roof with copper flashing. Tin as flashing is permissible. Lead and zinc endure but melt quickly in case of fire.

Is flue lining necessary?

Yes, always. And it should be of fire clay, not ordinary tile whether glazed or unglazed. There should be a separate flue for the furnace, another for a kitchen coal stove, and a third large one for open fireplace. It is best to separate linings from each other with a thickness of one brick, but if they meet their joints should at least be "staggered."

How thick should the chimney walls be outside flue lining?

AT THE back of an open fireplace, the width of two bricks laid flat, or eight inches. One brick wide, or four inches, will do above. Solid concrete or concrete block of the same thickness is permissible only when it is well reinforced with metal. A chimney of cut stone masonry should be twice as thick as brick or reinforced concrete, while rubble or field stone needs a thickness of one foot. Hollow tile is allowed only when such a chimney is built into an exterior hollow tile wall.

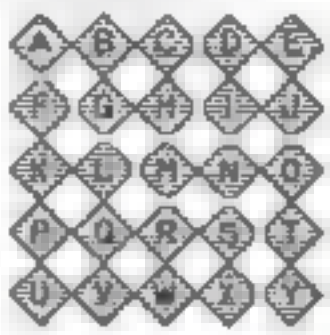
Are there other fire precautions?

Keep flues clean to avoid soot fires. Make smokepipe connection to flue air-tight with asbestos mixture. Renew furnace smokepipe every two years or so. Fireproof ceiling above furnace heater with metal sheet or otherwise. Keep a fire extinguisher handy in the kitchen—for which detail you will be thankful some day.

Answers to the Sam Loyd Puzzles on Page 65

The Diamond Cutting Test

This diagram shows how the five-by-five square can be constructed from four sections cut from the two smaller groups. If you reached a solution in fifteen minutes, you did unusually well.



A Brain Teaser in Letters

1. Rock. 2. Crab. 3. Sail. 4. Crust. 5. Bell. 6. Easter. 7. Grill. 8. Heart. 9. Post. 10. Trail. Fifteen minutes is excellent time.

Counting the Children

Before the twins arrived there were 12 in the household, including the farmer and his wife, and the barrel of flour lasted 21 days. When the family increased to 14 the barrel of flour lasted only 18 days. If they had four more members the barrel would last only 14 days. There are at present 12 children in the family. Twelve minutes is good time for the solution.

The "Twenty-Five Up" Game

Games of the character of Twenty Five Up, wherein two players build up a common sum until a certain total is reached, are best analyzed by working backwards step by step until the most advantageous start is found.

The novel feature of Twenty Five Up is that at each pass after the first two, two of the six numbers, top and bottom of the dice, are unavailable for the following player. This opens up a field of new calculation for a player must not only aim to leave certain totals for his opponent, but also leave out of play the very numbers which he could best employ.

An analysis of the game reveals that winning totals to leave for one's opponent are:

25, provided 1 or 6 is top number; 24 with 3 or 4 up; 21 with 5 or 6 up; 20 with 2 or 5 up; 17 with 3 or 4 up; 16 always wins; 13 with 5 or 6 up; 12 with 3 or 4 up; 11 with 2 or 5 up; 8 with 3 or 4 up; 7 always wins.

Losing stages are: 23, 19, 18, 15, 14, 10, 9. Don't ever leave these totals for your opponent to play on.

The advantage is with the first player who calls out the opening number, although the second player with a lucky throw of the dice may gain a winning position and maintain it throughout the game. However, the chances are against him.

If the first player selects 1, the second player can only win by throwing 5 or 6, so the chances are two to one against him, as he is just as likely to throw 1, 2, 3 or 4, as the 5 or 6.

If the first player selects 2, the second player can only win by throwing 3, so in this instance the odds are 5 to 1 against him.

If the first player selects 3, only the throw of 4 would beat him. If he selects 4, then 3 or 4 would beat him. If he selects 5, 2 or 3 would beat him. If he selects 6, 1 or 5 would beat him.

So in starting the game, the player who "sets the pace" has a decided advantage, since by selecting 2 or 3, he leaves for his opponent only a 5 to 1 chance in throwing the lie for a winning second number. If you reasoned this out in 25 minutes, you did exceptionally well.

The Letter Equation

Substituting figures for letters the result is as follows: 38 times 38 equals 1,444.

Words Made from Lines

1. Veterinarian. 2. Fermentative. 3. Impenetrable. 4. Wearisome. 5. Misinterpret. 6. Nonsensical. 7. Indemnified. Twenty minutes is good time.

Hope for Hay Fever Victims

(Continued from page 28)

hay fever case which came to a clinic supervised by Dr William Scheppegrell, president of the American Hay Fever Prevention Association, the doctors were at a loss to know why the patient should suffer in season and out, irrespective of the prevalence of pollen. Close study revealed that the sufferer belonged to a class especially affected by dust proteins. A series of skin tests showed that his nostrils were irritated by dust from the coffee bean. Further inquiry disclosed that the man, in the course of business, made occasional visits to a coffee warehouse and that the attacks followed such visits. He discontinued the calls, and the malady disappeared.

Some people cannot eat fish without an attack of sneezing. Others must go without oysters, meats, wheat flour products, eggs or lettuce. In one case, according to Doctor Scheppegrell, an attack may be aggravated by a piece of watermelon. In another, the trouble may be caused by peaches.

"SOME hay fever victims may be surprised to find that their symptoms are aggravated in theaters," Doctor Scheppegrell told me. "Virtually all modern amusement halls operating in summer are supplied with powerful fans. These draw in pollen-laden air in enormous quantities. The safe rule here is to avoid such places of amusement."

A shower following a warm bath is recognized as an excellent means of toning the skin and stimulating the nervous system in hay fever cases. The baths make the patient less sensitive to changes of temperature and to air currents which would tend to increase the irritation of the nostrils.

"ONE of the best methods of preventing hay fever," said Doctor Scheppegrell, "is to pass the season in some location where the patient finds relief. In the fall season many thousand patients sojourn at the so-called hay fever resorts.

"Long journeys, however, are not always necessary in spring attacks. The same results, in many cases, may be obtained by moving to a more central portion of the home city. This has been found to give entire relief, for the number of hay fever pollens is greatly reduced in the more densely populated portions of a city.

The records of the American Hay Fever Association indicate that the number of victims of the disease in the United States is steadily increasing. The increase is both apparent and actual. The apparent growth is due to the fact that many attacks formerly classified as summer colds, rhinitis and recurrent catarrh, today are recognized as hay fever. The real growth is due to the increase in travel facilities, particularly the automobile, bringing increased suburban settlement, with consequent exposure to the pollen of the countryside.

Strange Ants Grow Flowers

(Continued from page 29)

special, enormous honey sacs attached to their bodies. They are hung up alive by their hook-like feet, on the roof of the underground nest, where for the rest of their lives they serve as honey casks for the ant city and are "refilled" by their sisters when the supply runs low.

The Harvester ants of Europe gather grain and actually bake bread with it by molding the moistened sprouts into reddish-brown loaves and placing them in the hot sun. Some of the Harvesters line the ceilings of their subterranean nests with pebbles, petrified bones or shells. Even bits of gold have been found, thereby making credible the tale of the ancient historian Pliny of a race of gold-gathering ants in India.

Besides these curious ant tribes, described by Dr. Ewers in his recently published book, *The Ant People*, he tells how others keep small green plant lice as "cattle," and "milk" them for their sweet honey. This was the "manna" of Biblical story. As found by the Israelites, "the taste of it was like wafers made with honey. When the sun was hot it melted." But the manna fell on the leaves, not from heaven, but from the plant lice. The natives of Australia and other regions still prize it highly as food.

A CURIOUS sight, says Dr. Ewers, is an army of Nomad ants encamped for the night. Hundreds of thousands of them mass together in a living ball, sometimes a cubic yard in size, the queen and brood on the inside. Most surprising, passageways are left open, through which ants can run in and out of the ball over the bodies of their fellows. In case of flood, the strange ball will float.

Like men, ants keep in physical condition by indulging in wrestling bouts and mimic battles on the surface of their nests. In these contests they never hurt each other, refraining from using their powerful jaws or the mysterious insect-killing poison that some species can hurl for several yards.

Ants enjoy long life and startling vitality, Dr. Ewers says. Some queens have been known to attain an age of sixteen years—an astonishing span of life in the insect world. An American investigator froze ants in ice and thawed them out again alive and healthy. Others, kept eight days under water, revived when taken out. Such lightweights are ants that one could fall from the top of the highest building in the world without even breaking a leg. In some ways, their senses are superior to ours: for instance, an ant can perceive ultra-violet light, invisible to our eyes.

ARE they useful to men? Germany has passed a law protecting ants—the only one on record. Gathering their cocoons, or ant eggs, is prohibited, for the mature ants rid German forests of injurious insects. In southern China, bamboo rods are laid between the orange trees in mid-air so that ants, hung in bags from the limbs, may swarm freely from one tree to another and destroy the worms. They protect Italian fruit trees from caterpillars, and in this country they are used to fight the cotton-destroying boll weevil.

Science Saves Incubator Babies

ALL men created equal? Some are undersize and not ready for this cold world. For the baby weaklings that have to be helped over the first rough spots, and particularly for premature infants, ultra-modern accommodations have been provided at the Sarah Morris Hospital in Chicago. In this clinic, quartz lamps furnish artificial sunlight; dressing tables are electrically heated; and humidity registering apparatus and special thermometers for various purposes are part of the equipment.

Here Are Correct Answers to Questions on Page 45

1. This Spanish name—which means "The Captain"—has been given to one of the spectacular mountain cliffs in the Yosemite Valley in central California. The great cliff stands out into the valley from the mountain wall, like a commander in front of his troops.

2. This still is more or less of a mystery. Scattered over the eastern United States are roundish hills and long mounds. It is probable that these mounds were built by the ancestors of the American Indians.

3. The real sealskins now on the market are obtained, in the main, from the Pribilof Islands, in the Bering Sea, southwest of Alaska. Sealskins used to be obtained along the western coast, but the fur-bearing seal has been almost exterminated. It now is protected by strict governmental regulations.

4. In Spanish, "El Dorado" means "the gilded." The legend about it is a tale the Spaniards heard of a great city somewhere in America, the very walls and roofs of which were covered with solid gold. It is difficult now to reconstruct what may have been in the minds of the Indians or Aztecs who told the Spaniards this tale. They may have been thinking of the Inca palaces of Peru. The Spaniards found neither the place nor the gold.

5. Ambergris is not a perfume, but actually a fatty substance that accumulates inside the body of the sperm whale. It is thrown off by the whale and is found floating on the sea in huge masses. It is valuable for use in perfumery making because it absorbs other odors and gives them off slowly, and not because of any odor which it has itself.

6. More than three fourths of the world's coffee supply comes from Brazil.

7. This comes from the ancient Roman name for Ireland, which was Hibernia, meaning "wintry." Doubtless Ireland was so called because of its stormy winter climate, which must have seemed very severe to the Romans compared with the warm climate of Italy.

8. In the Sudan, Africa, British enterprises have constructed a railway that runs, in the main, parallel to the Nile. The country is desert, very hot and subject to tremendous sandstorms which frequently cover the railway tracks with sand. On a few occasions they actually have blown away the roadbed from underneath the rails.

9. This form of writing on clay was invented by the Babylonians more than 5,000 years ago. The soft clay was formed into small tablets. While the clay was soft, the writing was inscribed on it with a sharp-pointed instrument. The clay then was baked so that the writing was preserved permanently.

10. This description applies to the country of Tibet, lying north and northeast of the Himalaya Mountains. Tibet is the highest country in the world, and is sometimes called "the roof of the world."

11. The famous Easter Island, in the Pacific. It is inhabited by a few natives and whites who have contact with civilization only at infrequent intervals. Notwithstanding its isolation, the island contains giant statues carved out of hard volcanic rock. Scientists have not been able to decide what mysterious prehistoric race erected them.

12. Although most of the vanilla flavoring extracts on the market nowadays are made artificially, the original vanilla bean still is used to some extent. This bean is grown especially in the island of Tahiti, in the South Seas.

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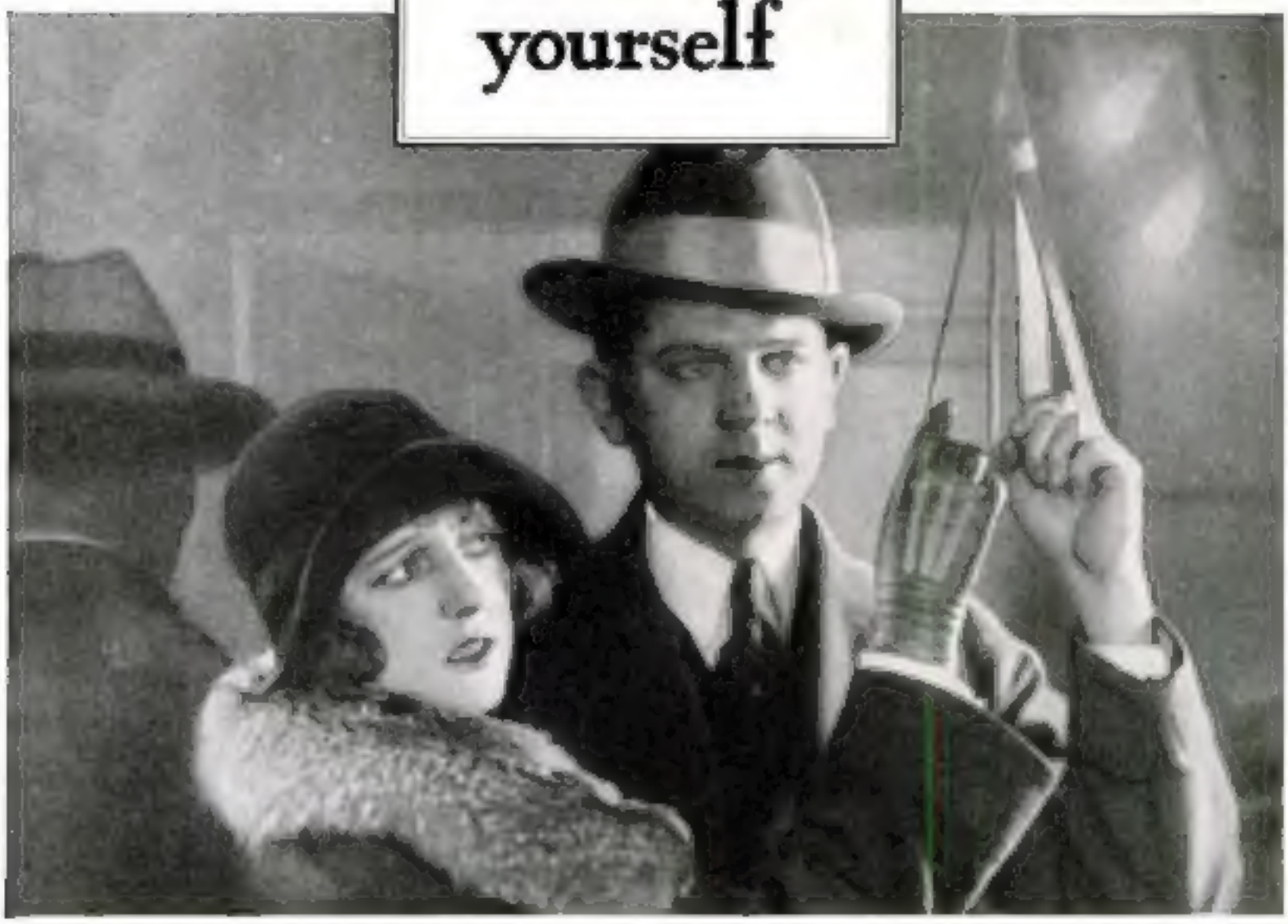

Halitosis easy to prevent

Nothing retards you in business, courtship and society like a real case of halitosis (unpleasant breath). It is a continual offense —and needless, too.

Since you, yourself, can never tell when you have halitosis, the only way to be sure of not offending is to rinse the mouth with Listerine every day — especially before any close personal contact.

⅓ Had Halitosis

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KRISS-KROSS is capable of such extraordinary performance that it is hardly fair to call it a stropper. Rather it is a *super-stropper* or blade *rejuvenator.* It not only prolongs the life of a single blade for weeks and months—but it produces a keenness of edge that hitherto has been almost unknown! *Actually* you can take a blade right out of a fresh package and improve it beyond belief in 11 seconds with KRISS-KROSS!

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KRISS-KROSS is sold by special representatives who will gladly demonstrate this remarkable invention for you without obligation. Right now they are authorized to make you an unusually generous introductory offer and are giving away a 3-way, adjustable razor entirely unlike anything you ever saw before! (See description at left.) If there is no representative in your neighborhood, you can secure the same generous offer direct from us. Use the coupon below for illustrated description and details

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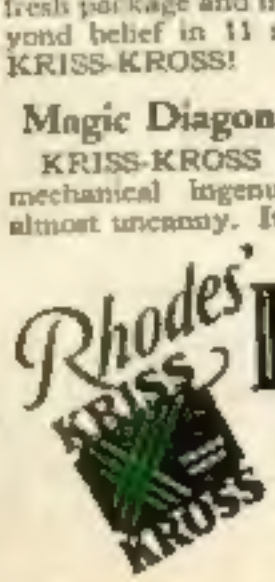
When men everywhere are making money like this as easily, it certainly is worth while for you to investigate. Why not start getting your share of these profits without delay? Mail the coupon while it is in front of you—before you forget!



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